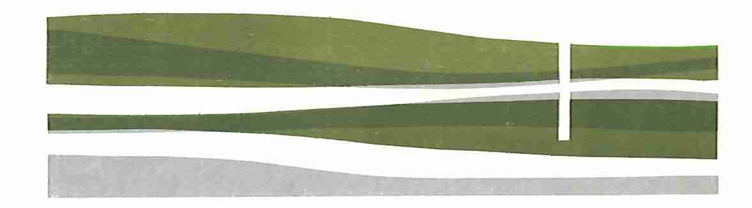
PROPOSED LEHRER LANDFILL SITE

KAUKAUNA, WISCONSIN



SOIL TESTING SERVICES OF WISCONSIN, INC.

540 LAMBEAU ST. GREEN BAY, WIS. 54303

August 11, 1976

Harris & Associates, Inc.
2718 North Meade Street
Appleton, Wisconsin 54911

Attention: Mr. Ted Harris

STS Job 6148-A

Re: Hydrogeological Report for the Proposed Lehrer Landfill Site, located in the Town of Buchanan in Outagamie County, Wisconsin.

Gentlemen:

In accordance with your authorization, we have completed the hydrogeological investigation of the above noted site. Enclosed herein are the results of this study and our engineering analysis for this project. The report distribution is noted on the following page.

In summary, our study concludes that the Lehrer Landfill Site has excellent potential for development into a solid waste disposal site in accordance with Chapter NR 151 of the Wisconsin Administrative Code.

If you have any questions with regard to this report, or if we can be of further service in any way, please do not hesitate to contact us.

Yours very truly,

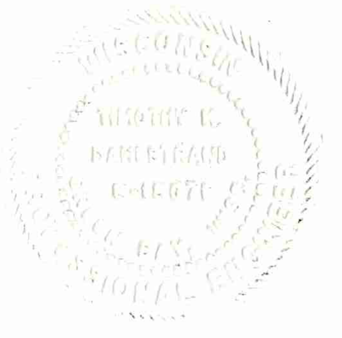
SOIL TESTING SERVICES OF WISCONSIN, INC.

Timothy K. Dahlstrand

Timothy K. Dahlstrand
Registered Professional Engineer, Wisconsin

William M. Perpich

William M. Perpich
Registered Professional Engineer, Wisconsin



TKD/pk

01025

COPY DISTRIBUTION

1 Lehrer Trucking Company
1604 Crooks Street
Kaukauna, Wisconsin 54130

1 Department of Natural Resources
812 South Fisk Street
Green Bay, Wisconsin 54304
Attention: Mr. Gary Kuilibert

1 Department of Natural Resources
P. O. Box 450
Madison, Wisconsin 53701
Attention: Mr. Bob Glebs

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INTRODUCTION

Pursuant to the State of Wisconsin Department of Natural Resources Modified Order No. 2A75-1045A, the hydrogeological report for the Lehrer Landfill, DNR License No. 73, has been prepared. The Lehrer landfill site is located in parts of sections 21 and 22, Township 21N, Range 18E, in the Town of Buchanan, Outagamie County, Wisconsin. At present, the east half of the Lehrer site (approximately 19 acres) have been landfilled and covered, and about 19 acres of additional land are being considered for a continued operation of the Lehrer landfill. Of this 19 acres, the northernmost 7 to 8 acres is in the process of being landfilled or has been landfilled Presently, the landfill operations in the active area consist of excavating a pit to approximately elevation +700 and then landfilling and covering back to the original site grade.

At the project site, vertical control is maintained by use of the Kaukauna City Datum. Horizontal control is determined by north-south and east-west stationing. These stations were developed by Carow Surveying and Harris & Associates, Inc. Using the indicated stationing, the proposed landfill development area will be located between the A and G line, and between station 11+00 and 0-200.

The purpose of this report is to describe the soil and geologic setting at the project site, to analyze the ground water table information, water quality and to present our recommendations regarding the site feasibility and conceptual design considerations.

01022

FIELD STUDY

AND SUBSURFACE INVESTIGATION PROCEDURES

The study of the Lehrer Landfill Site was begun in July, 1974 when two soil borings and wells were performed at the site. Subsequent topographic surveying of the site by Carow Surveying Company in November, 1975 followed. Following this initial work, additional soil borings and wells were performed at this site in December, 1975, January, 1976, and March, 1976. All of the information generated from the soil borings is included with this report. In addition, a topographic map adapted from the Carow Land Surveying drawing is provided.

Of the initial wells installed before December, 1975 only one boring (B1) has remained useable. In addition to the initial installation, 16 additional borings were performed and observation wells installed. The enclosed soil boring location diagram locates each boring and well location.

The wells were installed at this site such that they are nested at each location. That is, each location has wells at various tip elevations in order to observe the ground water conditions at a given elevation. At the locations of borings 1, 3, and 5, shallow monitoring wells were installed in order to determine the uppermost water phreatic surface. Also, one well (B7) has been installed within the now abandoned refuse area between borings 1 and 3. Of the 18 wells installed at this site, 15 wells are presently operable. Those wells which have been lost are B2, B3, and B3C.

The soil boring locations for this project were selected by project engineers of Soil Testing Services of Wisconsin, Inc. In order to determine the soil and ground water table conditions at the site. The boring depths were selected such that vertical and horizontal ground water gradients at the project site could be determined. The field locations of the soil borings and elevations were determined by Harris & Associates, Inc.

The soil borings for this project were performed with a truck mounted Joy Model 12-B rotary type drill rig. The bore holes were advanced by either a power

auger or by the wash boring technique. In the wash boring technique drilling wash water is introduced into the bore hole to remove any soil cuttings and the bore hole is kept open with steel casing. With the power auger, no drilling wash water is introduced into the bore hole. Representative soil samples were obtained by means of the split barrel and Shelby tube sampling procedures in accordance with ASTM Specifications D 1586-67 and D 1587-67, respectively. A description of these two sampling procedures is included in the Appendix of this report. At the nested well locations, only the deepest boring was sampled to define the soil conditions at that location. All soil samples obtained from the drilling procedures were labeled and sealed in the field, and then returned to our laboratory for further examination, testing, and classification.

Observation wells were installed in each of the soil borings after completion of the drilling operations. The well consisted of a 1 1/4 or 2 inch diameter polyvinylchloride (PVC) pipe. The bottom 18 inches of each pipe was slotted and wrapped with Filter X material. The slots were provided to allow ground water to enter the well and the Filter X material is to keep fine grained soils out of the well. The well was backfilled such that pea gravel was placed around the slotted tip of the well and was immediately overlain by a seal of bentonite pellets. The observation well was then grouted to the surface with a bentonite and cement grout. The relationship between the well tip and bentonite seals is indicated on the Schematic Diagram for Observation Well Installation, enclosed in the Appendix of this report. After each well was installed, the well was bailed so as to remove any excess drilling wash water from the well. The maximum depth of bailing is indicated on the Summary of Water Level Observations sheet in the Appendix. After installation of the observation wells, a series of water level readings were taken between February 5, 1976 and June 15, 1976. During this time period 8 sets of water level observations were obtained. All of the water level data is summarized in the Appendix. A detailed discussion of this data will be presented in a later section of this report.

LABORATORY TESTING PROGRAM

On soil samples obtained from the drilling operations, laboratory tests were performed to determine the physical and engineering characteristics of the soil. Specifically these tests were performed to evaluate the strength, compressibility, shrink-swell potential, and permeability. The results of all laboratory tests are noted on the enclosed soil boring logs and summary sheets included in the Appendix. The laboratory tests performed were water content, hand penetrometer or unconfined compressive strength tests, Atterberg limits, density determinations, and constant head permeability tests.

After completion of the laboratory testing program, each soil sample was carefully examined by an experienced soils engineer who noted color, major and minor soil components, degree of saturation, as well as any conspicuous lenses or seams. The soil was then classified on the basis of texture and plasticity in accordance with the Unified Soil Classification System. The estimated group symbol according to this system of classification is noted in parentheses following the written description of the soil on the boring logs.

In addition to the laboratory testing of the soils, laboratory testing of water samples obtained from the wells was also performed. To date the following wells have been sampled: boring B-1A, B-1B, B-4, B-4A, B-6, B-6A, and B-6B. The following parameters were tested: pH, conductivity, chloride, total dissolved solids, and COD. These parameters were selected to evaluate the ground water table quality downstream from the now abandoned landfill area, After completion of this testing, the State of Wisconsin Department of Natural Resources' letter was received. In this letter, it was requested that the following parameters be tested for on a one-time basis; pH, alkalinity/acidity ($CaCO_3$), hardness ($CaCO_3$), total dissoloved solids, COD, calcium, magnesium, sodium, iron, sulfate, and chloride. Also requested in this letter was a quarterly monitoring of the following parameters, pH, alkalinity/acidity ($CaCO_3$), hardness, sodium, chloride, sulfate, conductivity, and

iron. To date the entire list of requested parameters have not been performed. In conversations with the State Department of Natural Resources, it was agreed that the existing chemical tests would be reviewed and at that time the State of Wisconsin would request any additional chemical testing which they require.

In the following sections of this report, a detailed discussion of the existing soil conditions and their physical characteristics as well as an analysis of the ground water quality will be presented. All soil samples obtained from the drilling operations will be retained at the laboratory of Soil Testing Services of Wisconsin, Inc., for a period of 60 days, after which they will be discarded unless instructions as to their disposal are received.

GEOLOGIC SETTING AND SOIL CONDITIONS

On the basis of the soil borings performed at this site, the geologic setting and history is well defined. A dolomitic limestone bedrock of Ordovician Age was encountered at this site at approximately elevation +620. It was found that the bedrock was flat lying across the site. This bedrock elevation corresponds closely to that indicated in "Geology and Ground Water Resources of Outagamie County, Wisconsin", Geological Survey Water-Supply Paper 1421. The significance of the bedrock elevation is that it is located at such a substantial depth below the ground surface at this site.

Overlying the bedrock at the site, a layer of silty, gravelly clay was encountered. This likely represents a till deposit which was deposited during movement of ice sheets over the rock surface. This gravelly clay deposit is in turn overlain by a varved clay and silt deposit which extends from approximately elevation +635 to +680. The lower portion of this varved clay deposit had distorted varves which would indicate that there has been some subsequent reworking of the deposit. However, moving upward within the deposit, uniform varving occurs. These varved clays represent the seasonal deposition of fine grained soils in a relatively calm lake environment probably during the later Lake Oshkosh age. It is significant to note that the varved clay deposit thins substantially moving to the east (toward Kankapot Creek) with the thinning caused by erosion of the upper surface. This could have been caused by an ancient stream channel flowing through this area.

Above the varved clay deposit from approximately elevation +680 to the existing ground surface at this site, a uniform deposit of red brown silty clay was found. This upper clay stratum is a Valders Age till overlying the earlier Lake Oshkosh varved clay deposits. Subsequent retreat of the ice sheet has resulted in the formation of the Kankapot Creek Valley which is a later erosional feature through the Valders till.

01017

Enclosed in the Appendix of this report are two Generalized Soil Profiles on which the soil conditions encountered at the project site are depicted. Please note that the stratification lines on the Generalized Soil Profiles are extrapolated and estimated, based on soil conditions at the boring locations. Since these are estimates, variations should be anticipated between the depicted conditions and the actual conditions. The specific soil conditions encountered at each of the soil boring locations are noted on the enclosed soil boring logs. As before the stratification lines are meant to represent the approximate boundary between soil types while insitu the transition in a both a vertical and horizontal direction may be gradual. The majority of laboratory tests were performed within the Valders till strata. The definition of its strength and physical characteristics is imperative since the landfill will be located within this stratum. Atterberg limit tests indicate that this soil is predominantly a low plasticity clay and therefore would have little susceptibility to shrink and swell. This is significant since its use as a cover material is considered good. Laboratory permeability tests performed in this soil resulted in average coefficients of permeability between 2.9×10^{-8} and 7.6×10^{-9} cm/sec.

01016

GROUND WATER TABLE CONDITIONS

Observation wells were installed at five locations on the project site in order to determine the ground water flow characteristics. These wells were installed in a nested system such that the ground water potential may be evaluated at various elevations. On the enclosed Generalized Soil Profile, the latest water level data is indicated by an inverted triangle. Also included in the Appendix of this report is a summary of the water level observations obtained at the project site.

To date, eight sets of water level data have been obtained at the project site. Although 18 wells were initially installed for observing the water levels, only 15 are now operable. A general review of the observed ground water levels indicates some fluctuations are still being noted. In the well groupings at locations B-1, B-4 and B-6, appreciable water level fluctuations may be observed. The wells at location B-5 appear to be stabilized. The wells at location B-3 have undergone a significant fluctuation since their installation. There are factors which explain these fluctuations. Flucations at B-3 may be related to alterations of the site by excavation near the well locations. An additional contributing factor is that a number of groups of wells have been bailed for water quality sampling. This bailing requires working of the well prior to sampling which is accomplished by bailing the well to as deep a depth as possible and allowing it to recharge. Because of the relatively impermeable soils at this site, a significant time period will be required for the observation well to again stabilize after bailing and sampling.

Despite the fluctuation being observed in the water levels at this site a general ground water trend can be established, although the absolute gradients, both horizontal and vertical, can not be established. However, the gradients are not considered to be excessively high, based on available data, which results in the coefficients of permeability controlling flow rates.

A number of ground water contour sections have been prepared and are included in

the Appendix of this report. These ground water cross sections depict the equipotential lines for various elevation intervals across the site. Based on the final set of water level readings it may be observed that the ground water flow at the project site is generally in an east direction with components to the north and south depending upon the elevation range of interest. This is the same general ground water flow trend which was observed and submitted under separate cover in our preliminary hydrogeological report. This is a ground water recharge area.

As has been noted in the earlier section of this report the soil conditions at the site are well defined. Looking specifically at the permeabilities of the soils we expect that the uppermost red clay deposit will have coefficients of permeability comparable in both a vertical and horizontal direction. Therefore, we anticipate that extremely slow travel times for the ground water will occur within this soil strata. For the underlying varved clay deposit, we anticipate a somewhat faster movement in a horizontal direction than in a vertical direction. This is primarily due to the layered affect of the varves which will result in anisotropic coefficients of permeability. In general, however, the coefficients of permeability are so low that travel times, even under significant heads will be extremely slow at this site. Within the elevation range of +690 to +730, a horizontal gradient of 8.2×10^{-3} has been determined. Assuming an average coefficient of permeability of 3×10^{-8} cm/sec., a seepage velocity of less than 1.5 inches per year is expected. This order of magnitude would be typical of the expected flow velocity for ground water in this strata.

One observation well has been installed through the refuse and is indicated by boring 7. The observed water level within this well as of the last reading date is at elevation +718. It does not appear that the water level within the well has stabilized to date, however, the well does indicate that water accumulations are occurring within the refuse area.

01014

GROUND WATER QUALITY

As has been previously summarized in an earlier section of this report, a series of water quality tests have been performed on samples obtained from wells 1, 4, and 6. These well locations would represent sampling locations both upstream and downstream from the landfill site. The following parameters have been tested for: pH, conductivity, chloride, total dissolved solids, and COD. For purposes of comparison, the following table is presented on which comparable water tests from other sources in Outagamie County are presented.

TABLE I

Parameter	Lehrer Site	Other Values in Outagamie County*	Recommended Value for Public Water Supply**
pH	6.8 - 7.6	7.1 - 8.3	5.0 - 9.0
Total Dissolved Solids	248 - 970 mg/l	180 - 1460 mg/l	None established
Chloride	15.6 - 85.9mg/l	1.5 - 44 mg/l	Less than 250 mg/l

*Geology and Ground-Water Resources of Outagame Cojnty Wisconsin", Water Supply Paper 1421 and "Ground Water Quality in Wisconsin through 1972", University of Wisconsin-Extension, Information Circular No. 22.

** Water Quality Criteria, 1972, EPA.R3.73.033. March, 1973.

As may be noted by the above table, the measured water quality parameters at the Lehrer Site do not differ significantly from other reported values in Outagamie County and they fall within a range of acceptable concentration levels. Therefore, on the basis of these preliminary test results it appears that the existing landfill operation has not significantly altered the ground water quality at this site. This is an expected conclusion because of the types of soils encountered at the site; that is, the soils are uniform clay soils having low coefficients of permeability which would tend to minimize any movement of ground water or leachate through the site. As was earlier noted, additional water quality testing should be performed at this site on a periodic basis to continue to evaluate the water quality.

01013

ANALYSIS AND RECOMMENDATIONS

Site Feasibility In previous sections of this report, specific details as to soil conditions, soil characteristics, ground water table conditions and quality have been presented. On the basis of this information, it is our opinion that Lehrer landfill site is well suited for continued use as a sanitary landfill provided that the provisions of the Wisconsin Administrative Code Section NR 151 can be complied with. Specifically, it is our opinion that the site is well suited for the following reasons:

(1) The predominant soil type encountered at the Lehrer landfill site is a low permeability clay. Clay deposits in the proposed Lehrer landfill area have an approximate thickness of 100 feet. With the landfill excavation this would result in a separation from landfill bottom to bedrock at approximately 80 feet. These clay soils are uniformly fine grained having low coefficients of permeability.

(2) Bedrock is located at approximately elevation +620 at this site resulting in a separation of approximately 80 feet from the lowest landfill bottom.

(3) Movement of ground water at this site is in a general easterly direction with components to the north and south. This flow direction is generally away from residences which would have domestic wells.

(4) Preliminary ground water quality testing at this site both upstream and downstream from existing landfilled areas indicates normal ground water quality. This indicates that for the existing landfill operation no serious degradation of the ground water system has occurred to date.

(5) Because of the existing topography on the site surface, drainage may be easily controlled with the ultimate point of surface drainage being Kankapot Creek located east of the site.

(6) With the proposed method of landfill construction as pit excavation, an abundant source of daily and final cover material is available. It does appear however, There is a material shortage with regard to topsoil.

(7) Previous operation of the Lehrer Landfill Site has been done utilizing deep, near vertical side excavations. Based on the stability of these side cuts, similar excavations are considered feasible. These near vertical sidewalls provide maximum use of the available land for landfilling operations and generate the maximum amount of cover materials.

(8) Although residences are located north of the landfill site, the presence of a fill pile in this area minimizes the neighbor's view of the landfill area. This fill pile also assists in controlling blowing paper and limiting noise. The site is also set back approximately 1100 feet from State Highway 55 so that the site is not easily observed from this location.

Conceptual Design Considerations and Recommendations With regard to the design we have been in contact with Harris & Associates, Inc., regarding the development of the Lehrer Landfill Site. The preliminary design concepts were presented in an earlier submittal to the State of Wisconsin Department of Natural Resources. Specifically, the proposal is to utilize a staged construction of a series of cells within a 19 acre parcel of land. The cells will have a depth range between about 22.5 and 25.5 feet from the original ground surface resulting in an air volume capacity of between 52,900 and 75,200 cubic yards. The proposed bottom elevation for these cells will be in the range of elevation +700 with a bottom slope provided in the cell to allow for handling of surface water accumulations. The proposed side slopes of 0.5:1 are considered feasible for this site.

Provision will have to be made for truck access into the cells as well as areas for storage of daily cover material. Between each cell a berm will be provided to keep each cell isolated. The collection of surface water at the cell base will be provided by a series of berms extending the cell width. In this way, separation of any surface water accumulations and water leaching through the refuse can be maintained. We do not anticipate that ground water accumulations will be of any significant amount within the excavation since the rate of flow of the ground water through the excavation side walls will be so slow that it will likely be

removed by evaporation. Any seepage water contaminated with leachate will be recycled by pumping back into the refuse area.

It is proposed the Lehrer Landfill Site will be used for agricultural purposes after completion of the landfill operations. On the basis of a preliminary design concept of 3 feet of compacted clay cover, and 12 inches of topsoil, we feel this approach is reasonable. With regard to the clay final cover, we recommend that a low plasticity clay similar to that which would be excavated from the cell interior, be utilized. This clay should be placed in lifts not exceeding 9 inches in loose thickness and uniformly compacted to a minimum of 90% of the maximum density obtained in accordance with ASTM Specification D 698. We recommend that this clay be compacted near its optimum water content so as to minimize any potential for shrink or swell at a later date. Based on the results of the soil borings, it appears that there will be a shortage of topsoil at this site, and therefore, for obtaining the required 12 inches of final cover, it is likely that trucking will be necessary. We also recommend that final cover be mounded in such a manner that as landfill settlements occur, it will not adversely affect the surface drainage pattern at this site. We expect that a slope of 4 to 6% on the final grade should be adequate to account for this. It is proposed, as we understand, to return this site to near the original existing grade at the project site.

Based on the latest available ground water information, the landfill area will be located beneath the groundwater table at this site. Thus, we recommend that a leachate collection system be provided consisting of trenches backfilled with gravel with a center perforated pipe. This collection trench should lead to a sump hole located in the low corner of each cell. A riser pipe from this sump hole may then be used to monitor fluid levels within the sump hole as well as providing means for removing liquid accumulations. We recommend that if major accumulations of fluid are found in the sump hole that the leachate be recycled back into an operating landfill area by pumping. Long term handling considerations of the

leachates may be accomplished through use of local sewage treatment facilities or recycling. In conjunction with this system, we also recommend that gas vents be provided within the cells.

At present there is one main access road to the site. For construction of additional access roads, we recommend that any existing surface organic soils be stripped from the roadway area. The roadway should be constructed of a minimum of 12 inches of a properly compacted crushed stone or crushed gravel. Material conforming to Base Course gradation No. 1 of the State of Wisconsin Highway Specifications should be adequate. The roadway should also be crowned in order to assist in the runoff of water. Since truck access will be required to the base of the cells, adequate roads and turn-around areas will have to be provided for this equipment.

Future Considerations Because a landfill becomes a permanent feature in an area, long term considerations must be addressed with regard to the handling of any accumulated leachate. As was noted above, leachate may be treated at local sewage treatment facilities or recycling back into abandoned landfill areas through riser pipes. A second long term consideration at the Lehrer Landfill Site will be the periodic inspection of the presently landfilled area. This area should be inspected on the slope face to observe whether any leakage of leachate or erosion of the existing cover material has occurred. Should such conditions be found, then immediate corrective procedures should be implemented.

GENERAL QUALIFICATIONS

The analysis and recommendations contained in this report are based on the results of 18 soil borings performed at the indicated location. This report indicates our engineering judgement as to this project based on the available data and no warranty either expressed or implied is contained herein.

This report has been prepared pursuant to the State of Wisconsin Department of Natural Resources Modified Order No. 2A-75-1045 A for the Lehrer Landfill Project. This report is in partial fulfillment of Item I dealing with the final hydrogeological report.

INDEX

GENERAL NOTES

1950 Chicago Building Code Soil Classifications are Used Except Where Noted

DRILLING & SAMPLING SYMBOLS

SS : Split-Spoon – 1 3/8" I. D., 2" O. D., except where noted
ST : Shelby Tube – 2" O. D., except where noted
PA : Power Auger Sample
DB : Diamond Bit – NX: BX: AX:
CB : Carboloy Bit – NX: BX: AX:
OS : Osterberg Sampler – 3" Shelby Tube
HS : Housel Sampler
WS : Wash Sample
FT : Fish Tail
RB : Rock Bit
WO : Wash Out

Standard "N" Penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2 inch OD split spoon, except where noted.

WATER LEVEL MEASUREMENT SYMBOLS

WL : Water Level
WCI : Wet Cave In
DCI : Dry Cave In
WS : While Sampling
WD : While Drilling
BCR : Before Casing Removal
ACR : After Casing Removal
AB : After Boring

Water levels indicated on the boring logs are the levels measured in the boring at the times indicated. In pervious soils, the indicated elevations are considered reliable ground water levels. In impervious soils, the accurate determination of ground water elevations is not possible in even several days observation, and additional evidence on ground water elevations must be sought.

CLASSIFICATION

COHESIONLESS SOILS

"Trace"	:	1% to 10%	
"Trace to some"	:	10% to 20%	
"Some"	:	20% to 35%	
"And"	:	35% to 50%	
Loose	:	0 to 9 Blows	or equivalent
Medium Dense	:	10 to 29 Blows	or equivalent
Dense	:	30 to 59 Blows	or equivalent
Very Dense	:	≥ 60 Blows	or equivalent

COHESIVE SOILS

If clay content is sufficient so that clay dominates soil properties, then clay becomes the principle noun with the other major soil constituent as modifier; i.e., silty clay. Other minor soil constituents may be added according to classification breakdown for cohesionless soils; i.e., silty clay, trace to some sand, trace gravel.

Soft	:	0.00 — 0.59 tons/ft^2
Stiff	:	0.60 — 0.99 tons/ft^2
Tough	:	1.00 — 1.99 tons/ft^2
Very tough	:	2.00 — 3.99 tons/ft^2
Hard	:	≥ 4.00 tons/ft^2

PROCEDURES REGARDING FIELD LOGS, LABORATORY DATA SHEETS AND SAMPLES

In the process of obtaining and testing samples and preparing the report, procedures are followed that represent reasonable and accepted practice in the field of soil and foundation engineering.

Specifically, field logs are prepared during performance of the drilling and sampling operations which are intended to portray essentially field occurrences, sampling locations and other information.

Samples obtained in the field are frequently subjected to additional testing and reclassification in the laboratory by more experienced soil engineers, and differences between the field logs and the final logs exist.

The engineer preparing the report reviews the field and laboratory logs, classifications and test data, and in his judgement in interpreting this data, may make further changes.

Samples taken in the field, some of which are later subjected to laboratory tests, are retained in our laboratory for sixty days (60) and are then destroyed unless special disposition is requested by our client. Samples retained over a long period of time, even in sealed jars, are subject to moisture loss which changes the apparent strength of cohesive soil, generally increasing the strength from what was originally encountered in the field. Since they are then no longer representative of the moisture conditions initially encountered, an inspection of these samples could recognize this factor.

It is common practice in the soil and foundation engineering profession that field logs and laboratory test data sheets not be included in engineering reports, because they do not represent the engineer's final opinions as to appropriate descriptions for conditions encountered in the exploration and testing work. On the other hand, we are aware that perhaps certain contractors and subcontractors submitting bids or proposals on work might have an interest in studying these documents before submitting a bid or proposal. For this reason, the field logs will be retained in our office for inspection by all contractors submitting a bid or proposal. We would welcome the opportunity to explain any changes that have and typically are made in the preparation of our final reports, to the contractor or sub-contractors, before the firm submits its bid or proposal, and to describe how the information was obtained to the extent the contractor or sub-contractor wishes. Results of laboratory tests are generally shown on the boring logs or are described in the text of the report, as appropriate.

LOG OF BORING NO. 1

OWNER: Town of Buchanan

ARCHITECT-ENGINEER: Carow Land Surveying

SITE:

PROJECT NAME: Lehrer Landfill Site

SURFACE ELEVATION 724.7

DEPTH ELEVATION	SAMPLE NO.	TYPE SAMPLE	DESCRIPTION OF MATERIAL
	1	ST	Silty clay, trace sand, gravel cinders, roots-red brown to black-(CL-Fill)
	2	ST	
	3	ST	Silty clay, trace sand, gravel with occasional light brown silt seams-red brown-hard-(CL)
	4	ST	
10	5	ST	
	6	ST	Silty clay, trace sand, gravel trace decayed roots from 20' to 22' and 1/2" to 1" peat pockets-dark brown to brown-tough to hard-(CL-CH)
20	7	ST	
	8	ST	
30	9	ST	
	10	ST	
40	11	ST	
	12	ST	Varved red silty clay (CH) and gray brown silty clay (CL-CH) in 1/8" to 1/4" layers-very tough to tough-(CH & CL-CH)
50	13	ST	
	14	ST	
60	15	ST	
	16	ST	
70	17	ST	
77.0	18	ST	Silty clay, trace sand, gravel with a few irregular red clay seams-gray brown-tough to very tough-(CL-CH)

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1, 2, 3, 4, 5) — PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % — STANDARD "N" PENETRATION (BLOWS/FT.) (10, 20, 30, 40, 50)

UNIT DRY WT. LBS./FT.³

Plot labels: CL-CH, CH, CL-CH, CH, CL-CH, CH, CL-CH, CH

End of Boring

*Calibrated Penetrometer

Note:
1. Well point installed AB as per enclosed drawing with tip at 61.3' below ground surface
2. 2' of 4" casing used
3. Well point protector pipe installed
4. Elevation of top of PVC pipe-726.0

01004

WATER LEVEL OBSERVATIONS

W.L.	W.S. OR W.D.
W.L.	B.C.R. A.C.P.
W.L.	6.5' AB-Bailed hole to 30' & installed well points 42.0' after W.P. install

SOIL TESTING SERVICES OF WIS., INC. GREEN BAY, WISCONSIN 540 LAMBEAU STREET

BORING STARTED	7-9-74
BORING COMPLETED	7-10-74
RIG 28	FOREMAN EV
DRAWN JK	APPROVED TD
JOB #6143	SHEET

F.P. No. 42 1M

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF BORING NO. 1A

OWNER	ARCHITECT-ENGINEER
	Harris and Associates
SITE Highway 55 and CTH EE, Kaukauna, Wisconsin	**PROJECT NAME** Proposed Lehrer Landfill

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1, 2, 3, 4, 5)
PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT %
STANDARD "N" PENETRATION (BLOWS/FT.) (10, 20, 30, 40, 50)

SURFACE ELEVATION 725.4

DEPTH ELEVATION	SAMPLE NO.	TYPE SAMPLE	SAMPLE DIST.	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT. 3
5						
10		PA				
15					No soil sampling for installing well point at 40 feet	
20						
25		PA				
30						
35						
40					End of Boring	

WATER LEVEL OBSERVATIONS

W.L.	None to 40' AB
W.L.	B.C.R. / A.C.R.
W.L.	Bailed to 40.0' from top of PVC. Apparently dry to 40.0'

SOIL TESTING SERVICES
OF WIS., INC.
540 LAMBEAU STREET
GREEN BAY, WIS. 54303

BORING STARTED	12-23-75
BORING COMPLETED	12-23-75
RIG 22	FOREMAN BS
DRAWN KO	APPROVED TKD
JOB # 6148 A	SHEET 01003

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF BORING NO. B-1B

OWNER	ARCHITECT-ENGINEER Harris and Associates
SITE Highway 55 and CTH EE Kaukauna, Wisconsin	PROJECT NAME Proposed Lehrer Landfill

DEPTH ELEVATION	SAMPLE NO.	TYPE SAMPLE	SAMPLE DIST.	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT. 3	UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1, 2, 3, 4, 5); PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △; STANDARD "N" PENETRATION (BLOWS/FT.) ⊗ (10, 20, 30, 40, 50)
					SURFACE ELEVATION 725.4		
5							
10							
					Borehole advanced with power auger-no samples obtained		
15							
20							
25							
30							
					End of Boring Observation well installed after boring		

WATER LEVEL OBSERVATIONS		
W.L.		
W.L.	B.C.R.	A.C.R.
W.L.	3.6' on 3-16-76	

SOIL TESTING SERVICES
OF WIS., INC.
540 LAMBEAU STREET
GREEN BAY, WIS. 54303

BORING STARTED	3-15-76		
BORING COMPLETED	3-15-76		
RIG	W-15	FOREMAN	RR
DRAWN	KO	APPROVED	TKD
JOB #	6148 A	SHEET	

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

01002

LOG OF BORING NO. 2

OWNER	ARCHITECT-ENGINEER
Town of Buchanan	Carow Land Surveying
SITE	**PROJECT NAME**
	Lehrer Landfill Site

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.[*] (1, 2, 3, 4, 5)
PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT %
STANDARD "N" PENETRATION (BLOWS/FT.) (10, 20, 30, 40, 50)

SURFACE ELEVATION 729.7

DEPTH ELEVATION	SAMPLE NO.	TYPE SAMPLE	DESCRIPTION OF MATERIAL
	1	SS	Silty clay, trace to some sand-red brown-hard-(CL)
	2	ST	
	2A	ST	Silty fine sand, trace to some clay lumps, trace gravel-brown (SM-SC)
	3	ST	
	3A	ST	Silty, sandy clay, trace gravel-red brown-hard-(CL-SC)
	4	ST	
10	5	ST	Silty clay, trace sand, gravel with light gray brown silt seams-red brown-hard-(CL)
	6	ST	
20	7	ST	Silty clay, trace sand, gravel with trace decayed roots beginning at 25' to about 38.5'-3/4" peat layer at 36.8'-brown to dark brown-tough to hard-(CL-CH)
	8	ST	
30	9	ST	
	10	ST	
40	11	ST	
	12	ST	
	12A	ST	
50	13	ST	
	14	ST	Varved red silty clay (CH) and gray brown silty clay-(CL-CH) in 1/8" to 1/2" layers-very tough to hard-(CH & CL-CH)
60	15	ST	
	16	ST	
70	17	ST	
	18	ST	
80			Clayey, sandy gravel-brown-saturated-very dense-boulders from 79' to 81'-(GP-GC)
81.0	19	SS	

End of Boring

*Calibrated Penetrometer

100/4" Bounce

Note:
1. Well point installed after boring with tip at 57.0'
2. 2' of 4" Casing Used
3. Well point protector pipe installed
4. Elevation of top of PVC pipe - 731.9

01001

WATER LEVEL OBSERVATIONS		
W.L.	W.S. OR W.D.	
W.L.	B.C.R.	A.C.R.
W.L.	Before well point installation 4' ... installed well point-well point 17' after installation	

SOIL TESTING SERVICES OF WIS., INC.
[illegible]
GREEN BAY, WISCONSIN
540 LAMBEAU STREET

BORING STARTED	7-10-74		
BORING COMPLETED	7-10-74		
RIG	28	FOREMAN	EV
DRAWN	JK	APPROVED	TD
JOB #	6148	SHEET	

F.P. No. 4—1M

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF BORING NO. 3

OWNER	ARCHITECT-ENGINEER Harris and Associates
SITE Highway 55 and CTH EE Kaukauna, Wisconsin	PROJECT NAME Proposed Lehrer Landfill

DEPTH ELEVATION	SAMPLE NO.	TYPE SAMPLE	DESCRIPTION OF MATERIAL
			SURFACE ELEVATION 723.1
	1	ST	Reddish brown to brown silty clay with trace to some roots, trace gravel-very tough to hard-(CL)
	2	ST	
	3	ST	
	4	ST	Reddish brown silty clay with trace gravel-tough to hard-(CL)
10	5	ST	
	6	ST	Reddish brown silty clay with trace to some organics-tough to very tough-(CL) Permeability test on Sample 9
15	7	ST	
20	8	ST	
25	9	ST	
30	10	ST	
35	11	ST	
40	12	ST	
45	13	ST	Varved reddish brown to gray brown clay and silt-tough to very tough-(CL & ML) Permeability test on Sample 17
50	14	ST	
55	15	ST	
60	16	ST	
65	17	ST	
70	18	ST	Gray to gray brown silty clay with trace gravel-tough-(CL)
75	19	ST	
80	20	ST	
85	21	ST	
88			
			Continued

Columns also headed: SAMPLE DIST., RECOVERY, UNIT DRY WT. LBS./FT.3, UNCONFINED COMPRESSIVE STRENGTH TONS/FT.2 (1, 2, 3, 4, 5), PLASTIC LIMIT % X, WATER CONTENT % ●, LIQUID LIMIT % △, STANDARD "N" PENETRATION (BLOWS/FT.) ⊗ (10, 20, 30, 40, 50)

WATER LEVEL OBSERVATIONS	
W.L.	26.0' WD
W.L.	B.C.R. A.C.R.
W.L.	Bailed to 96.0' from top of PVC

SOIL TESTING SERVICES OF WIS., INC.
540 LAMBEAU STREET
GREEN BAY, WIS. 54303

BORING STARTED		12-10-75	
BORING COMPLETED		12-10-75	
RIG	22	FOREMAN	BS
DRAWN	KO	APPROVED	TKD
JOB #	6148 A	SHEET	1 of 2

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

BBS 1075

01000

LOG OF BORING NO. 3

OWNER	ARCHITECT-ENGINEER Harris and Associates
SITE Highway 55 and CTH EE Kaukauna, Wisconsin	PROJECT NAME Proposed Lehrer Landfill

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5) — PLASTIC LIMIT % X, WATER CONTENT % ●, LIQUID LIMIT % △ — STANDARD "N" PENETRATION (BLOWS/FT.) ⊗ (10 20 30 40 50)

DEPTH ELEVATION	SAMPLE NO.	TYPE SAMPLE	SAMPLE DIST.	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT. 3
					SURFACE ELEVATION	
88					Continued	
90	22	ST			Varved gray to gray brown clay and silt with trace to some gravel-tough to very tough-(CL & ML)	
95	23	ST				
100	24	ST			Gray gravel and clay-(GC)	
		RB			Weathered Dolomite	
105	Run #1	DB NX			Dolomite bedrock Recovery = 100% - RQD = 100%	
107					End of Boring	

*Calibrated Penetrometer

Water loss 100% at depth 106.5' to 107.0'
Obstructions from depth 100.0' to 104.0'
Observation well installed @ 101.0'

WATER LEVEL OBSERVATIONS	
W.L.	
W.L.	B.C.R. / A.C.R.
W.L.	Cave in @ 101.0' AB

SOIL TESTING SERVICES
OF WIS., INC.
540 LAMBEAU STREET
GREEN BAY, WIS. 54303

BORING STARTED 12-10-75	
BORING COMPLETED 12-10-75	
RIG 22	FOREMAN BS
DRAWN KO	APPROVED TKD
JOB # 6148 A	SHEET 2 of 2

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF BORING NO. 3-A

OWNER	ARCHITECT-ENGINEER Harris and Associates
SITE Highway 55 and CTH EE Kaukauna, Wisconsin	PROJECT NAME Proposed Lehrer Landfill

DEPTH ELEVATION	SAMPLE NO.	TYPE SAMPLE	SAMPLE DIST.	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT. 3	UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5) / PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △ / STANDARD "N" PENETRATION (BLOWS/FT.) ⊗ (10 20 30 40 50)
					SURFACE ELEVATION 723.0		
5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70					No soil sampling-installed well point at 70.0 feet		
					End of Boring		

WATER LEVEL OBSERVATIONS	
W.L.	23' WD
W.L.	B.C.R. A.C.R.
W.L.	Bailed to 69.0' from top of PVC

SOIL TESTING SERVICES
OF WIS., INC.
540 LAMBEAU STREET
GREEN BAY, WIS. 54303

BORING STARTED	12-15-75
BORING COMPLETED	12-15-75
RIG 22	FOREMAN BS
DRAWN KO	APPROVED TKD
JOB # 6148 A	SHEET

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

BBS 1075

00998

LOG OF BORING NO. 3-B

OWNER	ARCHITECT-ENGINEER: Harris and Associates
SITE: Highway 55 and CTH EE, Kaukauna, Wisconsin	PROJECT NAME: Proposed Lehrer Landfill

DEPTH ELEVATION	SAMPLE NO.	TYPE SAMPLE	SAMPLE DIST.	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT. 3	UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1, 2, 3, 4, 5) / PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △ / STANDARD "N" PENETRATION (BLOWS/FT.) ⊗ (10, 20, 30, 40, 50)
					SURFACE ELEVATION 724.39		
5		PA					
10							
15							
20					No soil sampling-installed well point at 45 feet		
25		PA					
30							
35							
40							
45					End of Boring		

WATER LEVEL OBSERVATIONS		
W.L.	23' WD	
W.L.	B.C.R.	A.C.R.
W.L.	Bailed to 46.0'	

SOIL TESTING SERVICES
OF WIS., INC.
540 LAMBEAU STREET
GREEN BAY, WIS. 54303

BORING STARTED	
BORING COMPLETED	
RIG	FOREMAN
DRAWN	APPROVED
JOB # 6148 A	SHEET

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

00997

LOG OF BORING NO. 3C

OWNER	ARCHITECT-ENGINEER Harris and Associates
SITE Highway 55 and CTH EE Kaukauna, Wisconsin	PROJECT NAME Proposed Lehrer Landfill

DEPTH ELEVATION	SAMPLE NO.	TYPE SAMPLE	SAMPLE DIST.	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.3	UNCONFINED COMPRESSIVE STRENGTH TONS/FT.2 (1 2 3 4 5); PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △; STANDARD "N" PENETRATION (BLOWS/FT.) ⊗ (10 20 30 40 50)
					SURFACE ELEVATION 723.04		
		PA					
5							
10		PA					
15					Borehole advanced with power auger no samples obtained		
20		PA					
25							
30					End of Boring Observation well installed after boring		

WATER LEVEL OBSERVATIONS		
W.L.		
W.L.	B.C.R.	A.C.R.
W.L.	17.8' on 3-16-76	

SOIL TESTING SERVICES
OF WIS., INC.
540 LAMBEAU STREET
GREEN BAY, WIS. 54303

BORING STARTED	3-15-76		
BORING COMPLETED	3-15-76		
RIG	W-15	FOREMAN	RR
DRAWN	KO	APPROVED	TKD
JOB #	6148 A	SHEET	

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

00996

LOG OF BORING NO. 4

OWNER	ARCHITECT-ENGINEER: Harris and Associates
SITE: Highway 55 and CTH EE, Kaukauna, Wisconsin	PROJECT NAME: Proposed Lehrer Landfill

SURFACE ELEVATION 667.1

DEPTH ELEVATION	SAMPLE NO.	TYPE SAMPLE	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT. 3
	1	ST	Red brown sandy clayey topsoil-with trace gravel and roots-very tough-(SC)	
	1A	ST		
	2	ST	Red brown silty clay-trace to some sand and gravel-stiff to very tough-(CL)	
	3	ST		
	4	ST		
10	5	ST	Red brown silty clay with trace to some gravel-tough to very tough-(CL)	
	6	ST		
	7	ST		
20				
	8	ST	Red brown silty clay with trace to some gravel, cobbles, and boulders-tough to very tough-(GC)	
30	9	ST		
	10	ST		
40	11	ST		
	12	ST		
50				132
52.0	13	ST		

End of Boring

Boulders or obstructions from 18' to 22'
Boulders likely from 18' to end of boring
Observation well installed

*Calibrated Penetrometer

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1, 2, 3, 4, 5)
PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT %
STANDARD "N" PENETRATION (BLOWS/FT.) (10, 20, 30, 40, 50)

WATER LEVEL OBSERVATIONS		
W.L.		
W.L.	B.C.R.	A.C.R.
W.L.	0.5' AB	
	Bailed to 50.0' from top of PVC	

SOIL TESTING SERVICES
OF WIS., INC.
540 LAMBEAU STREET
GREEN BAY, WIS. 54303

BORING STARTED 12-31-75	
BORING COMPLETED 1-2-76	
RIG 22	FOREMAN BS
DRAWN KO	APPROVED TKD
JOB # 6148 A	SHEET

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF BORING NO. 4-A

OWNER	ARCHITECT-ENGINEER
	Harris and Associates
SITE Highway 55 and CTH EE Kaukauna, Wisconsin	PROJECT NAME Proposed Lehrer Landfill

DEPTH ELEVATION	SAMPLE NO.	TYPE SAMPLE	SAMPLE DIST.	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT. 3	UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5); PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT %; STANDARD "N" PENETRATION (BLOWS/FT.) (10 20 30 40 50)
					SURFACE ELEVATION 667.1		
0–30					No samples - well point installed at 30.0 feet		
30					End of Boring		

WATER LEVEL OBSERVATIONS		
W.L.		
W.L.	B.C.R.	A.C.R.
W.L.	0.5' AB	
	Bailed to 31.0'	

SOIL TESTING SERVICES
OF WIS., INC.
540 LAMBEAU STREET
GREEN BAY, WIS. 54303

BORING STARTED	
BORING COMPLETED	
RIG	FOREMAN
DRAWN	APPROVED
JOB # 6148 A	SHEET

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

00991

LOG OF BORING NO. 5

OWNER	ARCHITECT-ENGINEER Harris and Associates
SITE Highway 55 and CTH EE Kaukauna, Wisconsin	PROJECT NAME Proposed Lehrer Landfill

SURFACE ELEVATION 728.9

Depth / Elevation	Sample No.	Type Sample	Description of Material	Unit Dry Wt. lbs./ft.3
	1	ST	Brown sandy topsoil-hard-(SC)	
	1A	ST	Brown silty clay with trace to some sand and gravel-very tough to hard-(CL)	
	2	ST		
5	3	ST		
	4	ST	Red brown silty clay with trace gravel-tough-(CL)	112
10	5	ST		
	6	ST	Brown clayey silt with trace sand and gravel-hard-(ML)	113
15	7	ST	Brown silty clay with trace gravel-soft to tough-(CL-CH)	118
20	8	ST	Permeability Test on Sample 8	
25	9	ST	Red brown silty clay with trace gravel and woody fibers-very tough to hard-(CL)	106
30	10	ST		
35	11	ST		
40	12	ST	Red brown silty clay with occasional silt seams-hard-(CL)	
45	13	ST		
50	14	ST		
55	15	ST		
60	16	ST	Varved red brown clay and gray brown silt 1/4" to 1.0" in thickness-tough to very tough-(CL & ML) Permeability test on Sample 18	
65	17	ST		
70	18	ST		
75	19	ST		
80	20	ST		
85	21	ST	Gray brown silty clay with trace to some gravel and occasional seams of red clay-tough-(CL) Permeability test on Sample 22	
90 / 92	22	ST		
			End of Boring Observation well installed at 90.0'	

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1, 2, 3, 4, 5)
PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT %
STANDARD "N" PENETRATION (BLOWS/FT.) (10, 20, 30, 40, 50)

*Calibrated Penetrometer

WATER LEVEL OBSERVATIONS		
W.L.		
W.L.	B.C.R.	A.C.R.
W.L.		

SOIL TESTING SERVICES OF WIS., INC.
540 LAMBEAU STREET
GREEN BAY, WIS. 54303

BORING STARTED		12-18-75	
BORING COMPLETED		12-22-75	
RIG	22	FOREMAN	BS
DRAWN	KO	APPROVED	TKD
JOB #	6148 A	SHEET	1 of 1

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

BBS 1075

00993

LOG OF BORING NO. 5-A

OWNER	ARCHITECT-ENGINEER Harris and Associates
SITE Highway 55 and CTH EE Kaukauna, Wisconsin	PROJECT NAME Proposed Lehrer Landfill

DEPTH ELEVATION	SAMPLE NO.	TYPE SAMPLE	SAMPLE DIST.	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT. 3	UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5) PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △ STANDARD "N" PENETRATION (BLOWS/FT.) ⊗ (10 20 30 40 50)
					SURFACE ELEVATION 729.1		
0–25		PA			No soil sampling well point installed at 70.0 feet		
25–70		FT					
70					End of Boring Obstruction at 66.0 feet		

WATER LEVEL OBSERVATIONS	
W.L.	19.0' WD
W.L.	B.C.R. A.C.R.
W.L.	63.1' after bailing

SOIL TESTING SERVICES
OF WIS., INC.
540 LAMBEAU STREET
GREEN BAY, WIS. 54303

BORING STARTED	12-16-75
BORING COMPLETED	12-18-75
RIG 22	FOREMAN BS
DRAWN KO	APPROVED TKD
JOB # 6148 A	SHEET

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

00992

BBS 1075

LOG OF BORING NO. 5-B

OWNER	ARCHITECT-ENGINEER Harris and Associates
SITE Highway 55 and CTH EE Kaukauna, Wisconsin	PROJECT NAME Proposed Lehrer Landfill

DEPTH ELEVATION	SAMPLE NO.	TYPE SAMPLE	SAMPLE DIST.	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.3	UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5); PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT %; STANDARD "N" PENETRATION (BLOWS/FT.) (10 20 30 40 50)
					SURFACE ELEVATION 729.0		
5							
10							
15		FT					
20					No soil sampling-well point installed		
25					at 50.0 feet		
30							
35							
40							
45							
50							
					End of Boring		

WATER LEVEL OBSERVATIONS		
W.L.	49.8' AB	
W.L.	B.C.R.	A.C.R.
W.L.	Bailed to 49.8' from top of PVC	

SOIL TESTING SERVICES
OF WIS., INC.
540 LAMBEAU STREET
GREEN BAY, WIS. 54303

BORING STARTED	
BORING COMPLETED	
RIG 22	FOREMAN
DRAWN KO	APPROVED TKD
JOB # 6148 A	SHEET

00991

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF BORING NO. B-5 C

OWNER	ARCHITECT-ENGINEER Harris and Associates
SITE Highway 55 and CTH EE Kaukauna, Wisconsin	PROJECT NAME Proposed Lehrer Landfill

DEPTH / ELEVATION	SAMPLE NO.	TYPE SAMPLE	SAMPLE DIST.	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT. 3	UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5) / PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △ / STANDARD "N" PENETRATION (BLOWS/FT.) ⊗ (10 20 30 40 50)
					SURFACE ELEVATION 729.3		
5							
10							
15					Borehole advanced with power auger no samples obtained		
20							
25							
30							
35					End of Boring		Observation well installed after boring

WATER LEVEL OBSERVATIONS

W.L.		
W.L.	B.C.R.	A.C.R.
W.L.	2.9' on 3-16-76	

SOIL TESTING SERVICES
OF WIS., INC.
540 LAMBEAU STREET
GREEN BAY, WIS. 54303

BORING STARTED	3-15-76		
BORING COMPLETED	3-15-76		
RIG	W-15	FOREMAN	RR
DRAWN	KO	APPROVED	TKD
JOB #	6148 A	SHEET	

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

00990

LOG OF BORING NO. 6

OWNER	ARCHITECT-ENGINEER: Harris and Associates
SITE: Highway 55 and CTH EE, Kaukauna, Wisconsin	PROJECT NAME: Proposed Lehrer Landfill

SURFACE ELEVATION: 678.84

Depth	Sample No.	Type Sample	Description of Material
	1	ST	Red brown to brown silty clay with trace to some sand and gravel and with trace to some roots, woody fibers and black peaty pockets-possibly fill material-soft to very tough-(CL) Permeability test on Sample 2
	2	ST	
5	3	ST	
	4	ST	
10	5	ST	
	6	ST	
15	7	ST	Irregularly varved red brown clay and gray brown silt with trace gravel-tough-(CL-ML) Permeability test on Sample 9
20	8	ST	
25	9	ST	
30	10	ST	Brown silty clay with trace to some gravel in the form of limestone pieces-trace to some cobbles and boulders-tough-(CL)
35	11	ST	
40	12	ST	REFUSAL, BOULDER
45	13	SS	N = 31
50	14	SS	Brown silty clay with trace to some sand, gravel, cobbles and boulders-hard-(GC) — 75/6"
55	15	SS	80/6"
60	16	SS	Weathered broken rock — 100/6"
65.5		RB	

End of Boring
61' of NX casing

Boulders or obstructions from 43' to end of boring
Observation well installed at 64.5'

*Calibrated Penetrometer

Chart legend: UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1–5); PLASTIC LIMIT % X; WATER CONTENT % ●; LIQUID LIMIT % △; STANDARD "N" PENETRATION (BLOWS/FT.) ⊗ (10–50); UNIT DRY WT. LBS./FT.³

WATER LEVEL OBSERVATIONS

W.L.	10.0' WS
W.L.	5.0' B.C.R. 5.0' A.C.R.
W.L.	27.0' AB
	Bailed to 27.0' from top of PVC

SOIL TESTING SERVICES OF WIS., INC.
540 LAMBEAU STREET
GREEN BAY, WIS. 54303

BORING STARTED	12-23-75		
BORING COMPLETED	12-23-75		
RIG	22	FOREMAN	BS
DRAWN	KO	APPROVED	TKD
JOB #	6148 A	SHEET	

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

BBS 1075

00989

LOG OF BORING NO. 6-A

OWNER	ARCHITECT-ENGINEER: Harris and Associates
SITE: Highway 55 and CTH EE, Kaukauna, Wisconsin	PROJECT NAME: Proposed Lehrer Landfill

DEPTH ELEVATION	SAMPLE NO.	TYPE SAMPLE	SAMPLE DIST.	RECOVERY	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 679.26)	UNIT DRY WT. LBS./FT. 3	UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1, 2, 3, 4, 5) / PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % / STANDARD "N" PENETRATION (BLOWS/FT.) (10, 20, 30, 40, 50)
5							
10		RB					
15							
20					No samples taken-well point installed at 51.0 feet		
25							
30							
35		RB					
40							
45							
50							
51.0					End of Boring		

WATER LEVEL OBSERVATIONS		
W.L.	0.5' AB	
W.L.	B.C.R.	A.C.R.
W.L.		

SOIL TESTING SERVICES
OF WIS., INC.
540 LAMBEAU STREET
GREEN BAY, WIS. 54303

BORING STARTED 12-31-75	
BORING COMPLETED 12-31-75	
RIG 22	FOREMAN BS
DRAWN KO	APPROVED TKD
JOB # 6148 A	SHEET

00988

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF BORING NO. 6-B

OWNER	ARCHITECT-ENGINEER Harris and Associates
SITE Highway 55 and CTH EE Kaukauna, Wisconsin	PROJECT NAME Proposed Lehrer Landfill

DEPTH ELEVATION	SAMPLE NO.	TYPE SAMPLE	SAMPLE DIST.	RECOVERY	DESCRIPTION OF MATERIAL SURFACE ELEVATION 679.24	UNIT DRY WT. LBS./FT. 3	UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² 1 2 3 4 5 PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % STANDARD "N" PENETRATION (BLOWS/FT.) 10 20 30 40 50
5							
10							
15		RB			No samples taken-well point installed at 36.0 feet		
20							
25							
30							
35							
36.0					End of Boring PVC broken off at ground		

WATER LEVEL OBSERVATIONS		
W.L.	0.5' AB	
W.L.	B.C.R.	A.C.R.
W.L.	34.4' after bailing	
	Bailed to 34.4' from top of PVC	

SOIL TESTING SERVICES
OF WIS., INC.
540 LAMBEAU STREET
GREEN BAY, WIS. 54303

BORING STARTED 12-30-75	
BORING COMPLETED 12-30-75	
RIG 22	FOREMAN BS
DRAWN KO	APPROVED TKD
JOB # 6148 A	SHEET 00987

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF BORING NO. 7

OWNER	ARCHITECT-ENGINEER Harris and Associates
SITE Highway 55 and CTH EE Kaukauna, Wisconsin	PROJECT NAME Proposed Lehrer Landfill

DEPTH ELEVATION	SAMPLE NO.	TYPE SAMPLE	SAMPLE DIST.	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT. 3	UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5); PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △; STANDARD "N" PENETRATION (BLOWS/FT.) ⊗ (10 20 30 40 50)
					SURFACE ELEVATION 725.4		
					Borehole advanced with wash boring through refuse fill-no samples taken		
5		PA					
10							
15		RB					
20							
		RB					
25							
30							
					End of Boring 25' of 4" casing used 2" observation well installed after boring		

WATER LEVEL OBSERVATIONS		
W.L.		
W.L.	B.C.R.	A.C.R.
W.L.	22.3' on 3-16-76	

SOIL TESTING SERVICES
OF WIS., INC.
540 LAMBEAU STREET
GREEN BAY, WIS. 54303

BORING STARTED 3-15-76	
BORING COMPLETED 3-16-76	
RIG W-15	FOREMAN RR
DRAWN KO	APPROVED TKD
JOB # 6148 A	SHEET 00986

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LEHRER LANDFILL

Job No. 6148-A

SUMMARY OF CONSTANT HEAD PERMEABILITY TEST RESULTS

Boring	Sample	Depth	Soil Description	Test Duration (Seconds)	Coefficient of Permeability (cm/sec)
3	9	25'-27'	Red brown silty clay with trace to some organic matter (CL)	60,300	5.0×10^{-9}
				25,200	1.3×10^{-8}
				242,100	4.9×10^{-9}
3	17	65'-67'	Varved reddish brown to gray brown clay and silt (CL & ML)	25,200	3.0×10^{-8}
				60,900	1.7×10^{-8}
				181,200	1.0×10^{-8}
5	8	20'-22'	Red brown silty clay, trace gravel (CL-CH)	64,800	2.6×10^{-8}
				30,600	4.8×10^{-8}
				71,700	2.4×10^{-8}
5	18	70'-72'	Varved red & brown clay & gray brown silt in ¼" to 1" seams (CL & ML)	25,200	8.1×10^{-9}
				60,900	5.0×10^{-9}
				27,000	9.0×10^{-9}
5	22	90'-92'	Gray brown silty clay, trace to some gravel, red clay seams (CL)	23,400	1.6×10^{-8}
				24,000	3.1×10^{-8}
				71,700	1.5×10^{-8}
6	2	2'-4'	Red brown to brown silty clay, trace to some sand, gravel-(CL)	87,300	2.8×10^{-8}
				60,300	2.5×10^{-8}
				25,200	3.3×10^{-8}

CONT'D

LEHRER LANDFILL

Job No. 6148-A

SUMMARY OF CONSTANT HEAD PERMEABILITY TEST RESULTS

Boring	Sample	Depth	Soil Description	Test Duration (Seconds)	Coefficient of Permeability (cm/sec)
6	9	25'-27'	Irregularly varved red brown clay & gray brown silt, trace gravel (CL-ML)	87,300	2.9×10^{-8}
				60,300	3.3×10^{-8}
				26,400	4.2×10^{-8}

LEHRER LANDFILL

SUMMARY OF WATER LEVEL OBSERVATIONS

Location	Elevation Top of PVC	Elevation Ground Surface	Elevation Bentonite Seal	Water Level After Bailing	Water Level 2-5-76	Water Level 2-10-76	Water Level 2-17-76	Water Level 2-26-76	Water Level 3-8-76	Water Level 3-23-76	Water Level 4-7-76
001 B1	725.4	724.7	665	*	*	690.7	690.4	690.4	*	700.4	*
002 B1A	726.9	725.4	688.5	Dry	689.9	692.2	693.9	694.9	696.9	698.9	700.3
003 B1B*****	726.9	725.4	725.0	716.4	-	-	-	-	-	-	722.7
4 B2*	731.9	729.7	726	*	*	*	*	*	*	*	*
004 B3	724.44	723.1	627	626.4	651.9	653.9	653.6	654.1	654.1	654.4	654.1
005 B3A	724.2	723.0	658	655.2	693.2	694.7	696.2	696.2	696.5	699.2	707.4
006 B3B	722.9	724.39	683	676.9	697.9	697.9	697.9	697.9	698.2	697.9	710.2
007 B3C*****	725.09	723.04	723	Dry	-	-	-	-			717.3
008 B4	668.5	667.1	620	618.5	638.1	641.8	644.5	648.3	651.1	653.5	655.4
009 B4A	668.6	667.1	639.5	638.6	645.3	647.1	648.8	650.6	652.9	655.6	656.8
010 B5	730.2	728.9	642.5	***	682.2	683.2	683.2	683.2	683.4	682.7	679.5
011 B5A	730.4	729.1	664	667.3	682.4	683.9	684.4	684.4	685.4	683.9	681.7
012 B5B	730.5	729.0	683.5	680.7	724.5	724.5**	716.5	718.0	717.5	717.5	717.5
013 B5C*****	731.2	729.3	729	715.2	-	-	-	-	-	-	727.9
014 B6	680.24	678.84	619	653.2	653.2	653.9	654.2	654.2	654.6	655.2	654.6
015 B6A	679.26	679.26	629.5	****	*	*	*	668.78	646.7	651.3	655.3
016 B6B	679.24	679.24	644.5	644.8	656.9	658.2	659.7	661.2	662.1	663.8	664.9
017 B7*****	727.55	725.4	725	711.6	-	-	-	-	-	-	712.3

Notes

1. All elevations referenced to Kaukauna City Datum
2. B1 and B2 completed in July, 1974. Remaining borings completed during December, 1975 and January, 1976.

* Unable to locate
** Rebailed to 693.5 on 2-10-76 WL @ 693.5, 1 Hr. after bailing
*** Could not bail below 682
**** Bailed on 3-8-76 to 646.7
***** Installed 3-15-76

6148-A

LEHRER LANDFILL

SUMMARY OF WATER LEVEL OBSERVATIONS

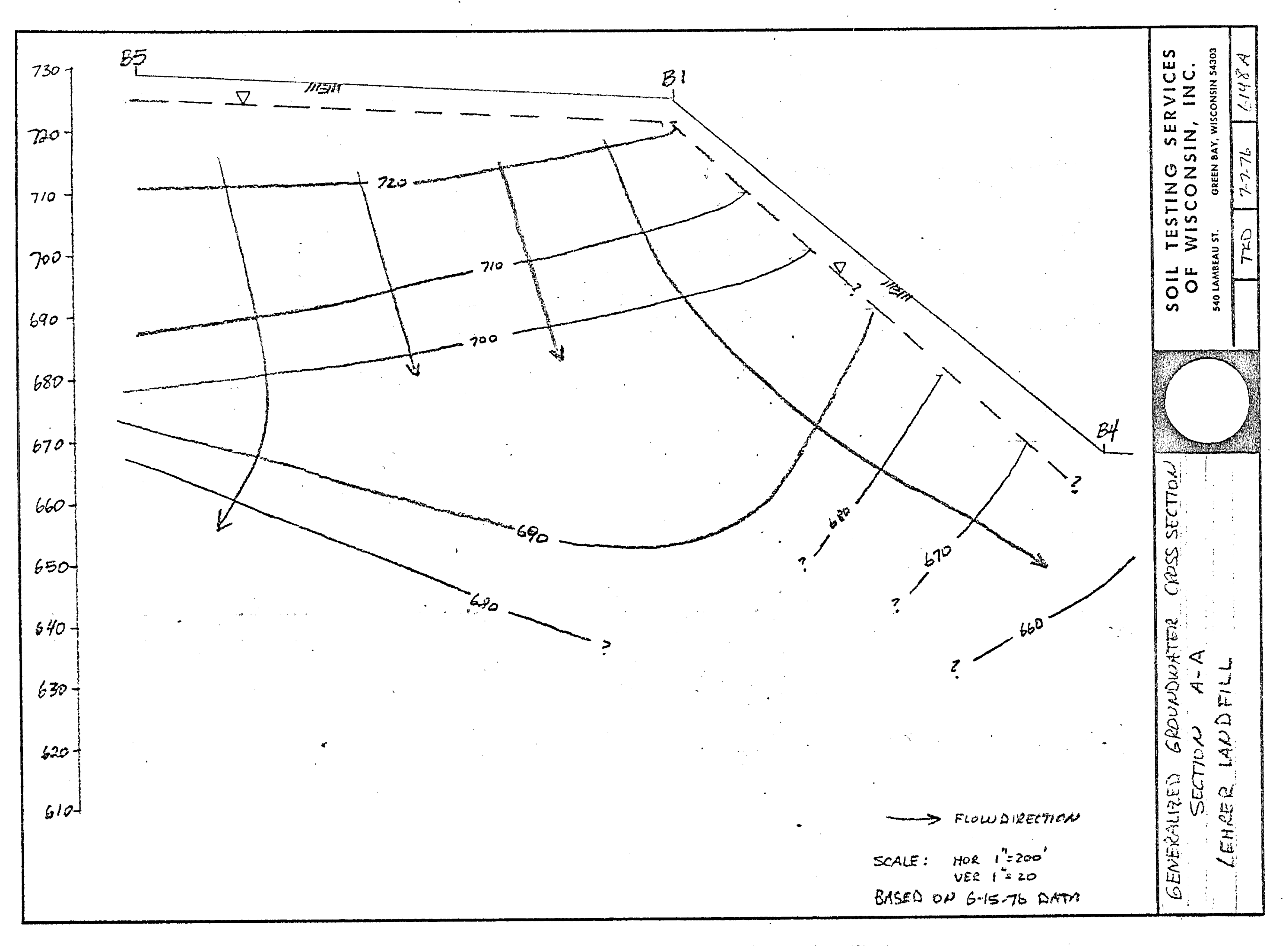
Location	Elevation Top of PVC	Elevation Ground Surface	Elevation Bentonite Seal	Water Level 6-15-76	Water Level	Water Level	Water Level	Water Level	Water Level
B1	725.4	724.7	665	693.0					
B1A	726.9	725.4	688.5	698.6					
B1B	726.9	725.4	725	720.9					
B2	731.9	729.7	726	-- Plugged @ 23'					
B3	724.44	723.1	627						
B3A	724.2	723.0	658	691.0					
B3B	722.9	724.39	683	692.0					
B3C	725.09	723.04	723	Plugged @ 20' Dry					
B4	668.5	667.1	620	653.6					
B4A	668.6	667.1	639.5	657.1					
B5	730.2	728.9	642.5	674.3					
B5A	730.4	729.1	664	676.5					
B5B	730.5	729.0	683.5	709.0					
B5C	731.2	729.3	729	725.5					
B6	680.24	678.84	619	653.8					
B6A	679.26	679.26	629.5	656.4					
B6B	679.24	679.24	644.5	665.4					
B7	727.55	725.4	725	718.0					

STS 6148 A

LEHRER LANDFILL

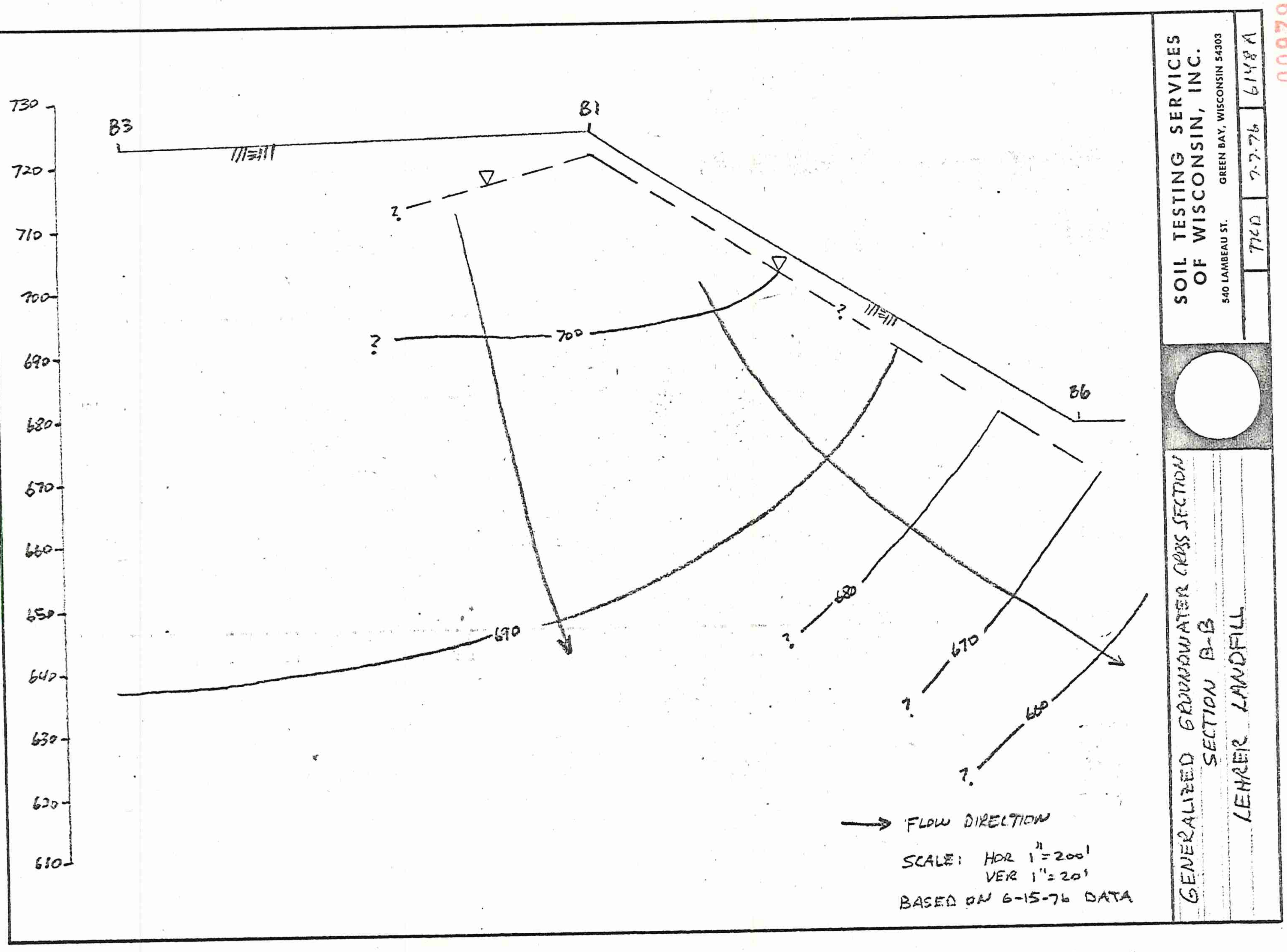
SUMMARY OF WATER QUALITY TESTS

Location	Date	pH	Conductivity mmohs/cm.	Chloride mg/L	TDS mg/1	COD mg/1.
B1B	4-8-76	7.5	1201	24.9	970	300
B1A	4-8-76	7.6	500	15.6	420	214
B4	4-8-76	6.8	447	43.0	248	126
B4A	4-8-76	7.2	582	50.0	420	190
B6	4-8-76	7.6	311	28.6	260	115
B6A	4-8-76	7.4	1134	85.9	880	470
B6B	4-8-76	7.3	819	58.2	660	400

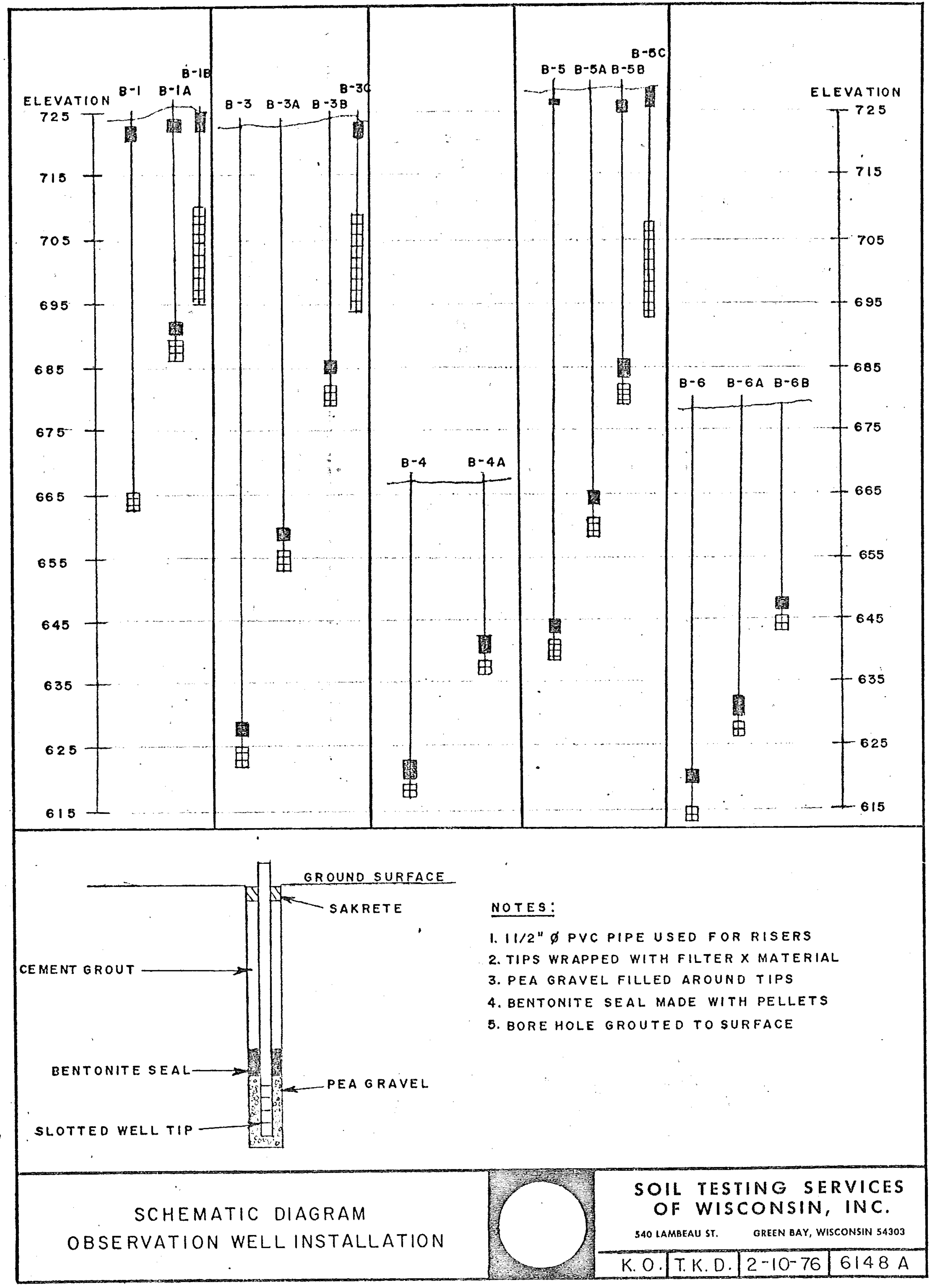


730
720
710
700
690
680
670
660
650
640
630
620
610
B5
B1
B4
WELL
WELL
720
710
700
690
680
680
670
660
FLOW DIRECTION
SCALE: HOR 1" = 200'
VER 1" = 20
BASED ON 6-15-76 DATA
SOIL TESTING SERVICES
OF WISCONSIN, INC.
540 LAMBEAU ST.
GREEN BAY, WISCONSIN 54303
TKD
7-7-76
6148A
GENERALIZED GROUNDWATER CROSS SECTION
SECTION A-A
LEHRER LANDFILL

00980


730
720
710
700
690
680
670
660
650
640
630
620
610
B3
B1
B6
?
700
690
680
670
660
FLOW DIRECTION
SCALE: HOR 1"=200'
VER 1"=20'
BASED ON 6-15-76 DATA
GENERALIZED GROUNDWATER CROSS SECTION
SECTION B-B
LEHRER LANDFILL
SOIL TESTING SERVICES OF WISCONSIN, INC.
540 LAMBEAU ST. GREEN BAY, WISCONSIN 54303
TKD
7-7-76
6148A

00979


ELEVATION
725
715
705
695
685
675
665
655
645
635
625
615
B-1
B-1A
B-1B
B-3
B-3A
B-3B
B-3C
B-4
B-4A
B-5
B-5A
B-5B
B-5C
B-6
B-6A
B-6B
GROUND SURFACE
SAKRETE
CEMENT GROUT
BENTONITE SEAL
PEA GRAVEL
SLOTTED WELL TIP
NOTES:
1. 11/2" Ø PVC PIPE USED FOR RISERS
2. TIPS WRAPPED WITH FILTER X MATERIAL
3. PEA GRAVEL FILLED AROUND TIPS
4. BENTONITE SEAL MADE WITH PELLETS
5. BORE HOLE GROUTED TO SURFACE
SCHEMATIC DIAGRAM
OBSERVATION WELL INSTALLATION
SOIL TESTING SERVICES OF WISCONSIN, INC.
540 LAMBEAU ST.
GREEN BAY, WISCONSIN 54303
K.O.
T.K.D.
2-10-76
6148 A

00978

OUTAGAMIE COUNTY, WISCONSIN, SOIL AND WATER CONSERVATION DISTRICT
IN COOPERATION WITH SOIL CONSERVATION SERVICE, USDA

BIE–IEE–51



USDA SCS LINCOLN, NEB. JAN. 1974–SR

APPROXIMATELY ONE MILE

ADVANCE FIELD SHEET
SUBJECT TO CHANGE

00977

SOIL NO. 100 & 99 [2]

MRTSC Trial Form
File Code Soils-12
Rev. 9-10-71

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS [1]

SERIES Kewaunee
STATE Wisconsin
MLRA 95

Well drained, gently sloping to steep soils with clayey subsoils and clayey substratums formed in glacial drift. These soils have moderate available water capacity and low permeability.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential
	USDA Texture	Unified	AASHO		4	10	40	200						
0-10	sil	ML, CL-ML	A-4	-	100	100	95-100	85-95	25-35	2-6	0.6-2.0	.22-.24	5.6-7.3	Low
10-24	c	CH	A-7	-	100	100	90-100	80-90	55-65	30-35	.06-0.2	.09-.11	5.6-6.5	High
24-60	c	CH	A-7	-	100	100	90-100	80-90	55-65	30-35	.06-0.2	.09-.11	7.4-8.4	Moderate

Flooding: None
Hydrologic group: C
Depth to water table: More than 5 feet
Depth to bedrock: More than 5 feet
Corrosivity - uncoated steel: Low
Corrosivity - concrete: Low

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Poor - low shear strength; high compressibility.
Sand	Unsuitable - excess of fines.
Gravel	Unsuitable - excess of fines.
Topsoil	Fair for 2 to 12% slopes; poor for steeper soils.

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Severe - slow permeability.
Sewage Lagoons	Moderate for 2 to 6% slopes; severe for steeper soils; slow permeability.
Shallow Excavations	Moderate - clayey subsoil and substratum; difficult to excavate.
Dwellings: With Basements / Without Basements	Moderate - clayey subsoil and substratum; moderate to high shrink-swell.
Sanitary Landfill	Moderate - clayey subsoil and substratum; difficult to work; slow permeability.
Local Roads and Streets	Severe - clayey subsoil and substratum; moderate to high shrink-swell; moderate frost action.
Potential Frost Action	Moderate - strong capillary action.

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Slowly permeable; clayey subsoil and substratum.
Embankments, Dikes, and Levees	Low shear strength; high compressibility.
Drainage of Cropland and Pasture	Natural drainage adequate.
Irrigation	Slow permeability; medium available water capacity.
Terraces and Diversions	Clayey subsoil and substratum; severe erosion hazard on steeper soils.
Grassed Waterways	Clayey subsoil and substratum; severe erosion hazard on steeper soils.
Golf Course Fairways:	Slowly permeable; slow to dry; muddy when wet.

1/ Use in conjunction with Guide to Soil Survey Interpretation Sheets.
2/ 99 soils are the * units.

00976

Series Kewaunee

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Moderate for 2 to 12% slopes; severe for steeper soils; slowly permeable; muddy when wet.
Picnic Areas	Slight for 2 to 6% slopes; moderate for 6 to 12% slopes; severe for steeper soils.
Playgrounds	Moderate for 2 to 6% slopes; severe for steeper soils; leveling may expose clayey subsoil.
Paths and Trails	Slight for 2 to 12% slopes; moderate for 12 to 20% slopes; severe for steeper soils; muddy when wet.

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss		Corn grain	Corn silage	Oats	
		K	T	(bu)	(T)	(bu)	
2-6%	IIe6	.43	3	85	15	75	
6-12%	IIIe6			80	13	70	
6-12%*	IVe6			70	10	60	
12-20%	IVe6			70	10	60	
12-20%*	VIe6			-	-	-	
20-30%	VIe6			-	-	-	
20-45%*	VIIe6			-	-	-	

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production
2-12%	Asl	Alfalfa-brome hay - 4.5 T/A; bluegrass pasture - 140 AUD.
12-20%	Asl	Alfalfa-brome hay - 4.0 T/A; bluegrass pasture - 130 AUD.
20-30%	Arl	Alfalfa-brome hay - 3.5 T/A; bluegrass pasture - 130 AUD.
6-20%*	Asl	Alfalfa-brome hay - 4.0 T/A; bluegrass pasture - 130 AUD.
20-45%*	Arl	Alfalfa-brome hay - 2.5 T/A; bluegrass pasture - 100 AUD.

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for --							Potential for--		
	Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Openland Wildlife	Woodland Wildlife	Wetland Wildlife
2-12%	Good	Good	Good	Good	Good	V. poor	V. poor	Good	Good	V. poor
12-20%	Fair	Good	Good	Good	Good	V. poor	V. poor	Fair	Good	V. poor
20-30%	V. poor	Fair	Good	Good	Good	V. poor	V. poor	Poor	Good	V. poor
6-12%*	Fair	Good	Poor	Fair	Fair	V. poor	V. poor	Fair	Fair	V. poor
12-45*	V. poor	Fair	Poor	Fair	Fair	V. poor	V. poor	Poor	Fair	V. poor

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity		Woodland Management Hazards				Suitable Species		Other
		Important Trees	Site Index	Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	To Favor	To Plant	
2-12%	2c1	red oak	MH	Slight	Slight	Slight	Slight	red oak	wh. pine	
6-12%*	2c1	sugar		Slight	Slight	Slight	Slight	sugar	wh.spruce	
12-30%	2c2	maple		Moderate	Moderate	Sl. N&E)	Slight	maple	bl. spruce	
12-30%	2c2	beech		Moderate	Moderate	Mod. S&W)	Slight			
20-45%*	2c2			Moderate	Moderate	do.	Slight			

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor

OTHER

MRTSC Trial Form
File Code Soils-12
Rev. 9-10-71

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS [1]

SOIL NO. 114

SERIES Bellevue

STATE Wisconsin

MLRA 95

Moderately well and well drained, reddish brown loamy alluvium. These sre nearly level and gently sloping, moderately permeable soils with a high available water capacity. They are subject to occasional flooding.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permea-bility in./hr.	Avail. Water Capac. in./in.	Soil Reac-tion pH	Shrink Swell Poten-tial
	USDA Texture	Unified	AASHO		4	10	40	200						
0-18	sil	ML	A-4	-	100	95-100	90-100	80-90	20-30	1-5	0.6-2.0	.22-.24	7.4-8.4	Low
18-36	hvy.sl	CL, CL-ML	A-4	-	100	80-90	60-70	40-50	15-25	5-10	0.6-2.0	.14-.16	6.6-7.8	Low
36-46	l	CL	A-6	-	100	90-100	80-90	60-70	25-35	10-20	0.6-2.0	.17-.19	7.4-7.8	Low
46-60	sicl	CL	A-7	-	95-100	90-100	80-90	85-95	40-50	20-30	0.6-2.0	.20-.22	7.9-8.4	Moderate

Flooding Occasional flooding for very brief periods.

Hydrologic group: B

Depth to water table: Seasonally, 3 to 5 feet

Depth to bedrock: More than 5 feet

Corrosivity - uncoated steel: Moderate

Corrosivity - concrete: Low

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Poor - medium to slow shear strength.
Sand	Poor - very little sand present.
Gravel	Poor - very little gravel present.
Topsoil	Good

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Severe - occasional flooding.
Sewage Lagoons	Severe - seasonal high water table; moderate permeability.
Shallow Excavations	Severe - occasional flooding.
Dwellings: With Basements	Severe - occasional flooding.
Dwellings: Without Basements	Moderate - occasional flooding.
Sanitary Landfill	Severe - occasional flooding; seasonal high water table.
Local Roads and Streets	Moderate - occasional flooding.
Potential Frost Action	Moderate - seasonal high water table; moderate capillary action.

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Moderate permeability; seasonal high water table.
Embankments, Dikes, and Levees	Medium to low shear strength; medium compressibility; moderate permeability.
Drainage of Cropland and Pasture	Seasonal high water table; moderate permeability.
Irrigation	Seasonal high water table; high available water capacity; moderately permeable.
Terraces and Diversions	Deep loamy soil; moderate permeability; occasional flooding.
Grassed Waterways	Deep loamy soil; occasional flooding.
Golf Course Fairways - seasonal high water table; moderate permeability; deep loamy soil.	

1/ Use in conjunction with Guide to Soil Survey Interpretation Sheets.

Series Bellevue

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Moderate - occasional flooding; seasonal high water table.
Picnic Areas	Moderate - occasional flooding; seasonal high water table.
Playgrounds	Moderate - occasional flooding; seasonal high water table.
Paths and Trails	Moderate - occasional flooding; seasonal high water table.

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss K	Soil Loss T	Corn grain (bu)	Corn silage (T)	Oats (bu)	
0-2%	IIwl1	-	-	100	16	75	
2-6%	IIwl1			95	15	75	

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production
0-6%	Aw1	Alfalfa-brome hay - 4.5 T/A; bluegrass pasture - 145 AUD.

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for-- Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Potential for-- Openland Wildlife	Woodland Wildlife	Wetland Wildlife
0-6%	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity: Important Trees	Site Index	Woodland Management Hazards: Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	Suitable Species: To Favor	To Plant	Other
0-6%	3o1	red oak red & silver maple ash basswood	56-60	Slight	Slight	Slight	Moderate	red oak red & silver maple	wh.spruce wh.cedar bl.spruce	

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor

OTHER

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Moderate - slippery after rains.
Picnic Areas	Moderate - slow permeability; slippery after rains.
Playgrounds	Moderate for 0 to 2% slopes; severe for steeper soils; slow permeability; compacts easily; muddy and slippery when wet; clayey subsoil.
Paths and Trails	Moderate - muddy and slippery when wet.

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss K	Soil Loss T	Corn grain (bu)	Corn silage (T)	Oats (bu)	
0-2%	IIs7	.37	3	85	12	75	
2-6%	IIe6			85	12	75	
6-12%	IIIe6			80	10	70	

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production
0-12%	As1	Alfalfa-brome hay - 4.0 T/A; bluegrass pasture - 140 AUD.

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for--							Potential for--		
	Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Openland Wildlife	Woodland Wildlife	Wetland Wildlife
0-6%	Good	Good	Good	Fair	Fair	Poor	Fair	Good	Fair	Poor
6-12%	Good	Good	Good	Fair	Fair	Poor	Poor	Good	Fair	Poor

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity		Woodland Management Hazards				Suitable Species		Other
		Important Trees	Site Index	Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	To Favor	To Plant	
0-12%	4o1	None	ML	Slight	Slight	Slight	Slight		wh. pine red pine Norway spruce	

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor

OTHER

MRTSC Trial Form
File Code Soils-12
Rev. 9-10-71

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS 1/

SOIL NO. 151
SERIES Winneconne
STATE Wisconsin
MLRA 95

Well drained soils with clay subsoils overlying calcareous lacustrine clays at depths of 20 to 40 inches. These are level to gently sloping and sloping, slowly permeable soils with medium available water capacity.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permea-bility in./hr.	Avail. Water Capac. in./in.	Soil Reac-tion pH	Shrink Swell Poten-tial
	USDA Texture	Unified	AASHO		4	10	40	200						
0-12	sicl	CH	A-7	-	100	100	95-100	90-100	40-50	20-30	0.6-2.0	.16-.20	6.6-7.3	Moderate
12-28	c c	CH	A-7	-	100	100	95-100	90-100	65-75	40-50	.06-0.2	.10-.14	6.1-6.5	High
28-60	c	CH	A-7	-	100	100	95-100	95-100	70-80	40-50	<0.06	.10-.14	7.9-8.4	High

Flooding None

Hydrologic group: C

Depth to water table: More than 5 feet.

Depth to bedrock: More than 5 feet

Corrosivity - uncoated steel: High

Corrosivity - concrete: Low

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Poor - low shear strength; poor compaction.
Sand	Unsuitable - little or no sand present.
Gravel	Unsuitable - little or no gravel present
Topsoil	Poor - difficult to work; crusts readily; clayey.

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Severe - slow permeability.
Sewage Lagoons	Slight for 0 to 2% slopes; moderate for 2 to 6% slopes; severe for steeper soils.
Shallow Excavations	Severe - difficult to work; high shrink-swell potential.
Dwellings: With Basements) Without Basements)	Severe - high shrink-swell potential.
Sanitary Landfill	Severe - very difficult to work; ponding hazard.
Local Roads and Streets	Severe - high shrink-swell potential; low shear strength.
Potential Frost Action	Moderate - strong capillarity.

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Slow permeability.
Embankments, Dikes, and Levees	Low shear strength; slow permeability; highly compressible.
Drainage of Cropland and Pasture	Nearly level areas may pond.
Irrigation	Slow permeability; medium available water capacity.
Terraces and Diversions	Slowly permeable; clayey; difficult to work.
Grassed Waterways	Slow permeability; difficult to work.
Golf Course Fairways - Clayey soil dries slowly; slippery when wet.	

1/ Use in conjunction with Guide to Soil Survey Interpretation Sheets.

SOIL NO. 239

MRTSC Trial Form
File Code Soils-12
Rev. 9-10-71

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SERIES Briggsville
STATE Wisconsin
MLRA 105

SOIL SURVEY INTERPRETATIONS [1/]

Well and moderately well drained, clayey soil overlying layered lacustrine silt and clay. These are nearly level to sloping moderately slowly permeable soils with a high available water capacity.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permea-bility in./hr.	Avail. Water Capac. in./in.	Soil Reac-tion pH	Shrink Swell Poten-tial
	USDA Texture	Unified	AASHO		4	10	40	200						
0-11	sil	ML	A-4	-	100	100	100	90-100	30-40	6-15	0.6-2.0	.20-.24	5.6-6.0	Moderate
11-31	sic	CH	A-7	-	100	100	100	90-100	55-60	30-35	0.2-0.6	.14-.18	5.1-6.0	High
31-60	sicl	CL	A-7	-	100	100	100	90-100	40-45	23-26	0.2-0.6	.16-.18	7.4-8.4	Moderate

Flooding None

Hydrologic group: C

Depth to water table: More than 5 feet

Depth to bedrock: More than 5 feet

Corrosivity - uncoated steel: Low

Corrosivity - concrete: Low

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Poor - fair stability; poor compaction.
Sand	Unsuitable - little or no sand present.
Gravel	Unsuitable - little or no gravel present.
Topsoil	Fair - thin topsoil material.

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Severe - moderately slow permeability.
Sewage Lagoons	Slight on 0 to 2% slopes; moderate on 2 to 6% slopes; severe for steeper soils; moderately slow permeability.
Shallow Excavations	Slight.
Dwellings: With Basements) Without Basements)	Moderate - moderate to high shrink-swell potential.
Sanitary Landfill	Moderate - some ponding in pits may occur; may be difficult to work when wet.
Local Roads and Streets	Moderate - moderate to high shrink-swell potential.
Potential Frost Action	Moderate - high capillary potential.

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Moderately slow permeability.
Embankments, Dikes, and Levees	Fair stability and compaction.
Drainage of Cropland and Pasture	Natural drainage is adequate.
Irrigation	Moderately slow permeability; high available water capacity.
Terraces and Diversions	Fair tilth; moderately slow permeability.
Grassed Waterways	Fair tilth; moderately slow permeability.
Golf Course Fairways - Severe - dries slowly; compacts easily.	

1/ Use in conjunction with Guide to Soil Survey Interpretation Sheets.

00970

Series Briggsville

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Moderate - sites remain soft, muddy and slippery for short periods; surface compacts easily.
Picnic Areas	Slight on 0 to 6% slopes; moderate for steeper soils; soft for short periods.
Playgrounds	Moderate on 0 to 6% slopes; severe for steeper soils; compacts easily and is soft, muddy and slippery for short periods; leveling may expose clayey subsoil.
Paths and Trails	Moderate - soft, muddy and slippery for short periods; erosive on slopes.

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss K	Soil Loss T	Corn grain (bu)	Corn silage (T)	Oats (bu)	
0-2%	IIs7	.43	3	100	16	70	
2-6%	IIe6			95	15	70	
6-12%	IIIe6			85	13	60	

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production
0-12%	As1	Alfalfa-brome hay - 4.0 T/A; bluegrass pasture - 140 AUD.

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for-- Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Potential for-- Openland Wildlife	Woodland Wildlife	Wetland Wildlife
0-6%	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor
6-12%	Good	Good	Good	Good	Good	Poor	V. poor	Good	Good	V. poor

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity: Important Trees	Site Index	Woodland Management Hazards: Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	Suitable Species: To Favor	To Plant	Other
0-12%	2c1	red oak sugar maple wh. ash basswood	MH	Slight	Slight	Slight	Slight	red oak sugar maple	wh. pine wh.spruce bl.spruce	

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor

OTHER

SOIL SURVEY INTERPRETATIONS

Each Soil Survey Interpretations sheet contains information about the properties and use of a specific soil. The soil series name is in the upper right corner of page 1 of the Soil Survey Interpretations sheet and below it is the number of the Resource Area [1] in which the soil most commonly occurs. A brief soil description follows the soil series name. The remainder of the sheet contains physical and chemical properties of soils and interpretations for various soil uses.

Interpretations for engineering, recreation, and woodland uses are given in terms of limitations and soil features affecting use. Limitations ratings are Slight, Moderate, Severe, and Very Severe. Interpretations for use of soils as roadfill, sand, gravel, topsoil, and wildlife are given in terms of suitability. These are Good, Fair, Poor, and Unsuitable or Very Poor. Ratings of Good or Slight indicate that, for a given use, the soil has no limitations or the limitations are easy to overcome. Fair or Moderate ratings mean that, for a given use, the soils have limitations that can be overcome by average management and manipulation. Poor or Severe ratings mean that, for a given use, soils have limitations that are difficult to overcome. Unsuitable, Very Poor, or Very Severe ratings indicate that the soils have limitations that generally preclude their use for a given purpose.

Soil use ratings are made for soils with slight or moderate erosion. Where erosion is severe (symbol 3), ratings for the use of soils for cropland, wildlife, recreation, and topsoil are one step more severe than the ratings for the same soils with slight or moderate erosion (symbols 1, 2). For example, a soil that has a Moderate rating for use as cropland, where erosion is slight or moderate, will have a Severe rating where erosion is severe. Similarly, soils with severe erosion should be placed in capability units that are one capability class higher (in number) than the units for slight and moderate erosion. Yields for soils with severe erosion are about 10 to 20 percent less than those given for soils with slight or moderate erosion. Slope classes are defined in Table 1.

TABLE 1.

SLOPE CLASS DESCRIPTION

Map symbol		Range in percent or	Slope description	
Letter	Numerical	fall per 100 feet	Simple	Complex
A	1	0 to 2	Nearly level	Nearly level
B	2 through 5	2 to 6	Gently sloping	Undulating
C	6 through 11	6 to 12	Sloping	Rolling
D	12 through 19	12 to 20	Moderately steep	Hilly
E	20 through 29	20 to 30	Steep	Steep
F	30 through 44	30 to 45	Very steep	Very steep

With the use of the soil map for identification, the data and interpretations in this section can be useful for many purposes. They do not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads or excavations deeper than the depth of layers here reported. Even in such situations, however, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that can be expected. Most soil areas indicated by delineations on the soil map contain small areas of soils other than those indicated by the name of the mapping unit. These inclusions cannot be avoided where maps are made at a scale of 4 inches per mile.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Near the top of page 1 of the Soil Survey Interpretations sheet, the estimated physical and chemical properties of the soil are given for the surface layer, subsoil, and substratum of a typical soil profile. Depths for other profiles of a particular soil series will vary within the prescribed range of the series. For example, the depths for the representative profile of Fayette silt loam: surface layer, 0-11 inches; subsoil, 11-47 inches; and substratum, 47-60 inches. In other Fayette profiles, the surface layer ranges from 5 to 16 inches thick, and

[1] Land Resource Regions and Major Land Resource Areas of the United States, Agriculture Handbook 296, SCS, USDA.

depth to the substratum ranges from 36 to 60 inches. Data are given for the substrata to a depth of 60 inches because soil scientists normally inspect the soil to that depth or to bedrock, whichever is shallower.

Classification includes the USDA textural class, the Unified classification[2], and the American Association of State Highway Officials (AASHO) classification[3]. The USDA textural class is based on the proportionate percent of sand, silt, and clay in the soil. The Unified and AASHO classifications are based on grain size, liquid limit, and plasticity.

Percent of the Soil Passing Sieve No. 4 (4.7 mm.), No. 10 (2.0 mm.), No. 40 (0.42 mm.), and No. 200 (0.074 mm.) are data that help in the interpretation of soils for engineering purposes. The percent gravel, sand, and percent fines (silt and clay) can be estimated from these data.

Liquid Limit (LL) and Plasticity Index (PI) reflect the percent and kind of clay in soils. In the surface layers the liquid limit is generally higher in proportion to plasticity index than in the subsoil and underlying material.

Permeability rates, expressed in inches per hour, represent the rate of water movement through a saturated soil. Soils with rates less than 0.06 inch per hour are said to be very slowly permeable. Other rates are: slowly - 0.06 to 0.2; moderately slow - 0.2 to 0.6; moderate - 0.6 to 2.0; moderately rapid - 2.0 to 6.0; rapid - 6.0 to 20; and very rapid - more than 20.

The Available Water Capacity value in inches per inch represents the amount of water that can be extracted from the soil by plants. Quantitatively, it is a vertical measurement of water that represents the difference between the amount of water that can be held at field capacity (about 1/3 atmospheres) and the wilting point (about 15 atmospheres). Value for soils to a depth of 5 feet can be obtained by multiplying the inches per inch for each layer by the thickness of the layer in inches. The sum of these values represents inches of available water in the soil profile. Adjective ratings used in Wisconsin for soils to a depth of 5 feet or to bedrock are: very low - less than 3 inches; low - 3 to 6 inches; medium - 6 to 9 inches; high - 9 to 12 inches; very high - more than 12 inches.

The Soil Reaction, expressed as a range in pH values for various soil layers, indicates the extent and depth of leaching of base chemicals originally present in the soil. Soils with pH values less than 6.5 are considered acid; pH values of 6.6 to 7.3 are considered neutral; and pH values greater than 7.3 are alkaline.

The Shrink-Swell Potential represents the difference in the volume of a given weight of soil when dry and when moist.

Other soil features that affect soil interpretations are listed below the table of soil properties. Flooding is characterized as None, Occasional, or Frequent. Depth to water table is estimated for wet seasons of the year. These depth ranges are less than 1 foot, 1 to 3 feet, 3 to 5 feet, and more than 5 feet. The Hydrologic group, designated A, B, C, or D indicates, in general, the amount of runoff to be expected from the soil when saturated. For most uses, the Depth to bedrock can be stated as less than 3 feet, 3 to 5 feet,. and greater than 5 feet. Corrosivity for steel and concrete are rated as low, moderate, or high.

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Soils suitable for Roadfill are generally a mixture of fines, sand, and gravel. Soils with low shrink-swell potential and good compaction characteristics are good sources of roadfill. These soils also have low frost action and low stone content.

The presence or absence of Sand or Gravel, or both, in the soil substratum is important to roadbuilders and other construction interests. Soils are rated according to the quality of sand or gravel (amount of fines), thickness of the deposit, the amount of stones and boulders in the deposit, depth to sand or gravel, and depth to ground water.

The suitability of soils for use as Topsoil is determined mainly by texture and thickness of the surface layer and subsoil, both of which are rated for this use. Coarse fragments such as pebbles, cobblestones, or stones are undesirable.

2/ Waterways Experiment Station, Corps of Engineers, 1953. The Unified Soil Classification System. Tech. Memo. 3-357, 2 v., and Appendix B, Vicksburg, Miss.

3/ American Association of State Highway Officials, 1961. Standard Specifications for Highway Materials and Methods of Sampling and Testing.

DEGREE AND KIND OF LIMITATIONS

The use of soils for Septic Tank Filter Fields refers to soil areas adjacent to tile fields that carry effluent from sewage septic tanks. There is sufficient effluent from the average sewerage system to require a moderate rate of transmittal of water by soils. Soils with moderate permeability are generally most favorable for leaching of effluents. Other important criteria are flood hazard, soil slope, and depth to bedrock or other impervious layers. Septic tank systems cannot be placed on soils that flood because of danger of downstream contamination of water. Soil slope in excess of 12 percent is important because effluent generally flows to the surface at low points. Soils that are less than 5 feet over bedrock do not provide sufficient depth for adequate leaching of effluent.

Sewage Lagoons function best in nearly level soils that transmit water slowly. The lagoon should be shallow to allow for maximum aeration and bacterial activity. Features other than slope and permeability that affect limitations of soils for their use are the amount of coarse fragments, the amount of organic matter in the soil, and the flood hazard.

Interpretations for Shallow Excavations provide an indication of the usefulness of soils for dwellings with basements, sanitary landfills, cemeteries, and underground utility lines.

The use of soils for Dwellings is separated into interpretations for dwellings With Basements and Without Basements. Hydrologic conditions such as slope, flooding, and wetness as well as properties that affect support of the foundation are considered. In addition, properties that affect installation of utility lines have a bearing on the rating.

Soil features affecting the use of the soil for Sanitary Landfill are mainly concerned with contamination of ground water by excessive leaching, or surface waters by surface runoff. The bottom of the site of a sanitary landfill should, ideally, be more than 12 feet to ground water, more than 5 feet to hard unfractured bedrock, and 12 feet to sandstone or fractured limestone (dolomite in Wisconsin). There should be few or no stones, the soil slope should be less than 6 percent, and there should be no flooding.

Local Roads and Streets are generally constructed with low cuts and fills from the material at hand. They are all-weather roads that are designed to carry only automobile traffic. The principal soil features that affect the limitations of soils for this use are flood hazard, depth to the water table, depth to bedrock, slope, shrink-swell potential, susceptibility to frost heave, and stoniness. Ideally the soil is sandy loam or coarser, is nearly level to gently sloping, and is not subject to flooding.

Potential Frost Action is related to the ability of the soil to transmit water by capillary action and the depth to free water. Somewhat poorly drained soils with silt loam or silty clay loam surface layers and subsoils generally have a high frost action.

MAJOR SOIL FEATURES AFFECTING SELECTED USE

Interpretations for Pond Reservoir Areas are based upon the ability of the undisturbed soil to hold water. Soil permeability, depth to bedrock, and soil slope are the principal criteria for determining the rating.

The soil used in Embankments, Dikes, and Levees must be disturbed, moved into place, and usually compacted. Features that affect this use are compaction characteristics, stability, susceptibility to sliding, shrink-swell potential, and susceptibility to piping.

Drainage of Cropland and Pasture by means of tile drains or open ditch drains will help remove excess water where ground water is less than 5 feet deep. Soil permeability, depth to bedrock, and soil stability are important features that affect soil drainage. In some soils, the use of tile drains is questionable because of a high content of silt and fine sand.

Irrigation design and use is mainly affected by soil features such as available water capacity and the water intake rate. Other features are susceptibility to water erosion, soil blowing, soil permeability, and slope.

The use of Terraces and Diversions helps control erosion on gently sloping to moderately steep soils in cultivation. Uniformity of slope, soil permeability, depth to sand and gravel, bedrock or clay, and the presence of stones affect the limitations of soils for this use. Similar soil properties affect the use of soils for Grassed Waterways.

Some features affecting the use of soils for Golf Course Fairways are listed in this section. Slope, wetness, and soil texture are important properties affecting this use.

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

The principal soil features affecting the use of soils for Camp Areas (tent and trailer) are wetness, the flood hazard, soil permeability, soil slope, surface texture, and the amount of gravel, stones, and rock outcrops on the soil surface. Ideally, a good camp area has good soil drainage, is nearly level or gently sloping, provides relatively good traction when wet, and has very few pebbles, stones, or rock outcrops.

Soil features affecting the use of soils for Picnic Areas are wetness, flooding, slope, surface texture, and the amount of gravel, stones, and rock outcrops. Ideal conditions are similar to those for camp areas, but some flooding and a few more stones and outcrops can be tolerated.

Soil features affecting use of soils for Playgrounds are wetness, flooding, permeability, soil slope, depth to bedrock, and the amount of gravel, stones, and rock outcrops on the surface. Ideally, the sites have good surface and internal drainage to a depth greater than 3 feet, do not flood during the season of use, are nearly level, have sandy loam or loam surface textures, are more than 40 inches deep to bedrock, and have very few pebbles, stones, or rock outcrops.

Paths and Trails should be relatively dry (water table below 20 inches during use season) and flood no more than once during the season of use. Slopes should be less than 15 percent and surface textures sandy loam or loam. Up to 20 percent of the surface can consist of gravel and up to 10 percent of rock outcrops. A few stones are permissible. Only the untreated soil upon which the trails are built are rated.

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS

Land capability unit and yield predictions are given for each slope class known to exist in the soil named on the sheet and for slight and moderate erosion.

Soil loss factors indicate the relative rate of soil erosion for each soil (K) and the tons of allowable loss per acre (T). K values range from .17 for some sandy soils to .43 for some loamy soils. T values are given for well drained, gently sloping to steep soils with slight to moderate erosion. The values range from 2 to 5.

Crop yields represent the potential yields that can be expected from soils on which a high level of management is practiced. This includes controlling erosion by vegetative and mechanical practices, maintaining soil structure and tilth favorable to plant growth by the return of plant residues to the soil; maintaining maximum plant growth by fertilizer and lime application according to soil tests.

PASTURELAND AND HAYLAND

The pasture group is based on soil limitations and yield. Yields for hay are given in tons per acre and for pasture in animal unit days.

WILDLIFE HABITAT SUITABILITY

Soil interpretations for wildlife are based upon the degree of suitability of each soil for different kinds of wildlife habitat and the importance of each kind of habitat to specific species of wildlife. The suitability ratings in the interpretative sheet are tempered by relative importance ratings in Table 2 of this text.

Suitability of the soil for Grain and Seed Crops and Grasses, Legumes are based on the ability of the soil to produce sufficient food and cover for wildlife needs. Yields are not significant where they exceed the requirements for good wildlife habitat.

Wild Herbaceous Plants include naturally-established grasses and forbs that can be used for food and cover for some species of wildlife. A wide variety of plants is desirable.

Hardwood Trees and Shrubs include trees, shrubs, and woody vines that produce food for wildlife in the form of fruit, nuts, buds, twigs, and foliage.

Coniferous Plants include cone-bearing trees that are used mainly for cover by wildlife but furnish some food in the form of browse, seeds, or fruitlike cones.

Wetland Food and Cover plants are those that grow well in wet areas and furnish food and cover for wildlife that inhabit these areas. The soils are classified as Type 1 and 2 wetlands by the U.S. Department of the Interior. Type 1 areas are usually dry during the growing season and Type 2 are not covered but are saturated during the growing season.

Shallow Water Developments include impoundments or excavations that provide shallow water areas for waterfowl and animals that require a water habitat. Shallow water areas are Type 3 and 4 wetlands described by the U.S. Department of the Interior as shallow marshes in which the soil is saturated or covered with as much as 6 inches to 3 feet of water during the growing season.

TABLE 2.

RELATIVE IMPORTANCE OF WILDLIFE HABITAT ELEMENTS TO SELECTED SPECIES OF WILDLIFE IN WISCONSIN

Selected wildlife species	Grain and seed crops		Grasses, legumes		Wild herbaceous plants	Woody plants			Wetland food and cover b/	Shallow water developments c/
						Hardwood		Coniferous plants		
	H	UnH	H	UnH		Shrubs	Trees			
Migratory Waterfowl										
Ducks	3	3	1	3	3	-	1	-	4*	4*
Geese	4	4	4	1	-	-	-	-	2	3
Upland Game Birds										
Hungarian partridge	4	4	3	4	4	1	-	-	1	-
Pheasants	4	4	-	4*	4*	4	-	1	4*	3
Quail	4	4	2	4	4	4*	2	1	4	3
Ruffed grouse	1	1	1	2	2	4*	4*	3	-	-
Sharp-tailed grouse	3	4	3	4	4	4	3	1	4	1
Woodcock	-	-	1	3	3	4	4	2	3	-
Small Game										
Cottontail rabbits	3	4	3	4*	4*	4*	3	1	2	3
Snowshoe rabbits	-	-	-	1	1	4*	3	4*	1	-
Raccoon	3	4	-	1	1	2	4	-	1	4*
Squirrels	3	4	-	1	1	2	4*	1	-	-
Larger Game										
Deer	3	4	3	3	4	4	4	4	3	3
Fur Bearers										
Beaver	-	-	-	-	-	4	4*	-	4	4
Red fox a/	2	3	2	3	3	3	2	1	3	3
Mink a/	-	-	-	-	-	2	1	1	3	4*
Muskrat	1	1	-	-	-	1	-	-	4	4*

* Key or critical elements for the species.
H Harvested; UnH Unharvested.
a/ Carnivorous species not strictly dependent on elements listed.
Wetlands as defined by United States Department of the Interior are:
b/ Type 1 and 2; c/ Type 3 and 4.
1 Little or no value to the species.
2 Some value to the species.
3 Important to the species.
4 Very important to the species.

WOODLAND SUITABILITY

The suitability and limitations of soils for use as woodland are indicated for each mapping unit of the soil series. The ordination symbol indicates the woodland suitability class (based mainly on productivity), the subclass (based on soil-induced hazards), and the woodland suitability group which indicates management differences within a subclass. The site index of trees that commonly grow in the soil is an indication of soil productivity for woodland. The table also includes limiting factors such as Erosion Hazard, Equipment Limitations, Seedling Mortality, and Plant Competition, and contains suggestions of species to plant.

AMERICAN SOCIETY FOR TESTING AND MATERIALS

1916 Race St., Philadelphia, Pa. 19103

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Standard Method for

PENETRATION TEST AND SPLIT-BARREL SAMPLING OF SOILS[1]



ASTM Designation: D 1586 – 67

This Standard of the American Society for Testing and Materials is issued under the fixed designation D 1586; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval.

1. Scope

1.1 This method describes a procedure for using a split-barrel sampler to obtain representative samples of soil for identification purposes and other laboratory tests, and to obtain a measure of the resistance of the soil to penetration of the sampler.

2. Apparatus

2.1 *Drilling Equipment*—Any drilling equipment shall be acceptable that provides a reasonably clean hole before insertion of the sampler to ensure that the penetration test is performed on undisturbed soil, and that will permit the driving of the sampler to obtain the sample and penetration record in accordance with the procedure described in 3. Procedure. To avoid "whips" under the blows of the hammer, it is recommended that the drill rod have a stiffness equal to or greater than the A-rod. An "A" rod is a hollow drill rod or "steel" having an outside diameter of $1\frac{5}{8}$ in. or 41.2 mm and an inside diameter of $1\frac{1}{8}$ in. or 28.5 mm, through which the rotary motion of drilling is transferred from the drilling motor to the cutting bit. A stiffer drill rod is suggested for holes deeper than 50 ft (15 m). The hole shall be limited in diameter to between $2\frac{1}{4}$ and 6 in. (57.2 and 152 mm).[2]

2.2 *Split-Barrel Sampler*—The sampler shall be constructed with the dimensions indicated in Fig. 1. The drive shoe shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. The coupling head shall have four $\frac{1}{2}$-in. (12.7-mm) (minimum diameter) vent ports and shall contain a ball check valve. If sizes other than the 2-in. (50.8-mm) sampler are permitted, the size shall be conspicuously noted on all penetration records.

2.3 *Drive Weight Assembly*—The assembly shall consist of a 140-lb (63.5-kg) weight, a driving head, and a guide permitting a free fall of 30 in. (0.76 m). Special precautions shall be taken to ensure that the energy of the falling weight is not reduced by friction between the drive weight and the guides.

2.4 *Accessory Equipment*—Labels, data sheets, sample jars, paraffin, and other necessary supplies should accompany the sampling equipment.

3. Procedure

3.1 Clear out the hole to sampling elevation using equipment that will ensure that the material to be sampled is not disturbed by the operation. In saturated sands and silts withdraw the drill bit slowly to prevent loosening of the soil around the hole. Maintain the water level in the hole at or above ground water level.

3.2 In no case shall a bottom-discharge bit be permitted. (Side-discharge bits are permissible.) The process of jetting through an open-tube sampler and then sampling when the desired depth is reached shall not be permitted. Where casing is used, it may not be driven below sampling elevation. Record any loss of circulation or excess pressure in drilling fluid during advancing of holes.

3.3 With the sampler resting on the bottom of the hole, drive the sampler with blows from the 140-lb (63.5-kg) hammer falling 30 in. (0.76 m) until either 18 in. (0.45 m) have been penetrated or 100 blows have been applied.

3.4 Repeat this operation at intervals not longer than 5 ft (1.5 m) in homogeneous strata and at every change of strata.

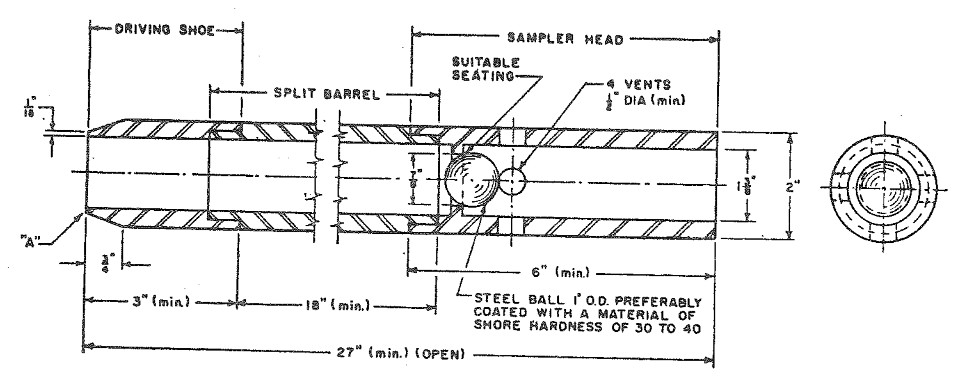
3.5 Record the number of blows required to effect each 6 in. (0.15 m) of penetration or fractions thereof. The first 6 in. (0.15 m) is considered to be a seating drive. The number of blows required for the second and third 6 in. (0.15 m) of penetration added is termed the penetration resistance, N. If the sampler is driven less than 18 in. (0.45 m), the penetration resistance is that for the last 1 ft (0.30 m) of penetration (if less than 1 ft (0.30 m) is penetrated, the logs shall state the number of blows and the fraction of 1 ft (0.30 m) penetrated).

3.6 Bring the sampler to the surface and open. Describe carefully typical

[1] Under the standardization procedure of the Society, this method is under the jurisdiction of the ASTM Committee D-18 on Soil and Rock for Engineering Purposes. A list of members may be found in the ASTM Year Book.
Current edition accepted Oct. 20, 1967. Originally issued 1958. Replaces D 1586 – 64 T.

[2] Hvorslev, M. J., *Surface Exploration and Sampling of Soils for Civil Engineering Purposes*, The Engineering Foundation, 345 East 47th St., New York, N. Y. 10017.

00963



NOTE 1—Split barrel may be 1½ in. inside diameter provided it contains a liner of 16-gage wall thickness.
NOTE 2—Core retainers in the driving shoe to prevent loss of sample are permitted.
NOTE 3—The corners at *A* may be slightly rounded.

TABLE OF METRIC EQUIVALENTS

in.	mm	cm	in.	mm	cm
1⁄16 (16 gage)	1.5	...	2	...	5.08
½	12.7	...	3	...	7.62
¾	19.0	1.90	6	...	15.24
⅞	22.2	2.22	18	...	45.72
1⅜	34.9	3.49	27	...	68.58
1½	38.1	3.81			

FIG. 1—Standard Split Barrel Sampler Assembly

samples of soils recovered as to composition, structure, consistency, color, and condition; then put into jars without ramming. Seal them with wax or hermetically seal to prevent evaporation of the soil moisture. Affix labels to the jar or make notations on the covers (or both) bearing job designation, boring number, sample number, depth penetration record, and length of recovery. Protect samples against extreme temperature changes.

4. Report

4.1 Data obtained in borings shall be recorded in the field and shall include the following:

4.1.1 Name and location of job,

4.1.2 Date of boring—start, finish,

4.1.3 Boring number and coordinate, if available,

4.1.4 Surface elevation, if available,

4.1.5 Sample number and depth,

4.1.6 Method of advancing sampler, penetration and recovery lengths,

4.1.7 Type and size of sampler,

4.1.8 Description of soil,

4.1.9 Thickness of layer,

4.1.10 Depth to water surface; to loss of water; to artesian head; time at which reading was made,

4.1.11 Type and make of machine,

4.1.12 Size of casing, depth of cased hole,

4.1.13 Number of blows per 6 in. (0.15 m),

4.1.14 Names of crewmen, and

4.1.15 Weather, remarks.

AMERICAN SOCIETY FOR TESTING AND MATERIALS

1916 Race St., Philadelphia, Pa. 19103

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Standard Method for

THIN-WALLED TUBE SAMPLING OF SOILS[1]



ASTM Designation: D 1587 – 67

This Standard of the American Society for Testing and Materials is issued under the fixed designation D 1587; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval.

1. Scope

1.1 This method describes a procedure for using a thin-walled metal tube to recover relatively undisturbed soil samples suitable for laboratory tests. It is intended as a guide to more complete specifications to meet the needs of a particular job.

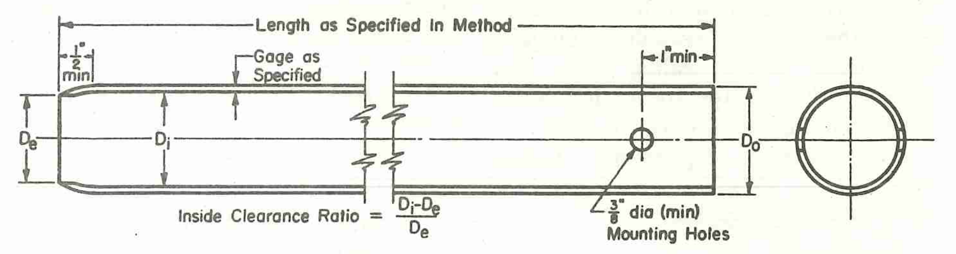
1.2 There are, in general, two types of samplers that use thin-walled tubes for sampling, namely, open-tube samplers, and piston samplers.[2] In general, piston samplers are better and can be used in almost all soils. Since the thin-walled tube requirements are the same for both types of samplers, the method described applies equally to both.

2. Apparatus

2.1 *Drilling Equipment*—Any drilling equipment may be used that provides a reasonably clean hole before insertion of the thin-walled tube; that does not disturb the soil to be sampled, and that can effect continuous and rapid penetration of the tube into the sampled soil.

2.2 *Thin-Walled Tubes*—Thin-walled tubes 2 to 5 in. (50.8 to 127 mm) in outside diameter and made of any materials having adequate strength and resistance to corrosion will be satisfactory (Fig. 1). Adequate resistance to corrosion can be provided by a suitable coating. Sizes other than these may be used, if specified.

2.2.1 Tubes shall be of such a length that between five and ten times the diameter is available for penetration into sands and between ten and fifteen diameters is available for penetration into clays. Tubes shall be round and smooth, without bumps, dents, or scratches. They shall be clean, and free from rust and dirt. Seamless or welded tubes are permissible, but welds must not project at the seam. The cutting edge shall be machined as shown in Fig. 1 and shall be free from



NOTE 1—Minimum of two mounting holes on opposite sides for 2 to 3½ in. sampler.
NOTE 2—Minimum of four mounting holes spaced at 90 deg for samplers 4 in. and larger.
NOTE 3—Tube held with hardened screws.

TABLE OF METRIC EQUIVALENTS.

in.	mm	cm
3/8	6.77	...
½	12.7	1.27
1	25.4	2.54
2	...	5.08
3½	...	8.89
4	...	10.16

FIG. 1—Thin-Walled Tube for Sampling.

TABLE 1—SUITABLE THIN-WALLED STEEL SAMPLE TUBES.[a]

Outside diameter:			
in.	2	3	5
mm	50.8	76.2	127
Wall thickness:			
Bwg	18	16	11
in.	0.049	0.065	0.120
mm	1.24	1.65	3.05
Tube length:			
in.	36	36	54
m	0.91	0.91	1.45
Clearance ratio, per cent	1	1	1

[a] The three diameters recommended in Table 1 are indicated for purposes of standardization, and are not intended to indicate that sampling tubes of intermediate or larger diameters are not acceptable. Lengths of tubes shown are illustrative. Proper lengths to be determined as suited to field conditions.

[1] Under the standardization procedure of the Society, this method is under the jurisdiction of the ASTM Committee D-18 on Soil and Rock for Engineering Purposes. A list of members may be found in the ASTM Year Book.
Current edition issued Oct. 20, 1967. Originally issued 1958. Replaces D 1587 – 63 T.

[2] Hvorslev, M. J., *Surface Exploration and Sampling of Soils for Civil Engineering Purposes*, The Engineering Foundation, 345 East 47th St., New York, N. Y. 10017.

nicks. The inside clearance ratio shall be between 0.5 and 3 per cent.

2.2.2 Two vent holes (3/8 in. (9.1 mm) minimum) shall be provided in the sampler head. A coupling head with a check valve and a minimum of 0.6 in.^{2} (3.9 cm^2) venting to outside above check valve shall be used. Table 1 shows the dimensions of suitable thin-walled sample tubes.

2.3 *Sealing Wax*—Any wax shall be permitted for sealing that does not have appreciable shrinkage, or does not permit evaporation from the sample. Microcrystalline waxes are preferable to paraffin. Thin disks of steel or brass that are slightly smaller than the inside diameter of the tube are desirable for plugging both ends before sealing with wax. Cheesecloth and tape are needed. Suitable expanding packers may be used.

2.4 *Accessory Equipment*—Labels, data sheets, shipping containers, and other necessary supplies.

3. Procedure

3.1 Clean out the hole to sampling elevation using whatever method is preferred that will ensure that the material to be sampled is not disturbed. In saturated sands and silts withdraw the drill bit slowly to prevent loosening of the soil around the hole. Maintain the water level in the hole at or above ground water level.

3.2 The use of bottom discharge bits shall not be allowed but, any side discharge bit is permitted. The procedure of jetting through an open-tube sampler to clean out the hole shall not be allowed.

3.3 With the sampling tube resting on the bottom of the hole and the water level in the boring at the ground water level or above, push the tube into the soil by a continuous and rapid motion, without impact or twisting. In no case shall the tube be pushed further than the length provided for the soil sample. Allow about 3 in. (75 mm) in the tube for cuttings and sludge.

3.4 When the soils are so hard that a pushing motion will not penetrate the sampler sufficiently for recovery, and where recovery by pushing in sands is poor, use a driving hammer to drive the sampler. In such a case, record the weight, height, and number of blows. Before pulling the tube turn it at least two revolutions to shear the sample off at the bottom.

3.5 Repeat the sampling procedures described at intervals not longer than 5 ft (1.5 m) in homogeneous strata and at every change of strata.

4. Preparation for Shipment

4.1 Upon removal of the sampler tube, measure the length of sample in the tube and also the length penetrated. Remove disturbed material in the upper end of the tube before applying wax and measure the length of sample again. After removing at least 1 in. (25 mm) of soil from the lower end, and after inserting an impervious disk, seal both ends of the tube with wax applied in a way that will prevent wax from entering the sample. Where tubes are to be shipped some distance, tape the ends to prevent breakage of the seals. It is advisable to place cheesecloth around the ends after sealing and dip the ends several times in the melted wax.

4.2 Affix labels to the tubes giving job designation, sample location, boring number, sample number, depth, penetration, and recovery length. Record a careful description of the soil, noting composition, structure, consistency, color, and degree of moisture. Mark the tube and boring numbers in duplicate.

4.3 Do not allow tubes to freeze, and store in a cool place out of the sun at all times. Ship samples protected with suitable resilient packing material to reduce shock, vibration, and disturbance.

4.4 Using soil removed from the ends of the tube, make a careful description giving composition, condition, color and, if possible, structure and consistency.

5. Report

5.1 Data obtained in borings shall be recorded in the field and shall include the following:

5.1.1 Name and location of job,

5.1.2 Date of boring—start, finish,

5.1.3 Boring number and coordinate, if available,

5.1.4 Surface elevation, if available,

5.1.5 Sample number and depth,

5.1.6 Method of advancing sampler, penetration and recovery lengths,

5.1.7 Type and size of sampler,

5.1.8 Description of soil,

5.1.9 Thickness of layer,

5.1.10 Depth to water surface; to loss of water; to artesian head; time at which reading was made,

5.1.11 Type and make of machine,

5.1.12 Size of casing, depth of cased hole,

5.1.13 Names of crewmen, and

5.1.14 Weather, remarks.

UNIFIED SOIL CLASSIFICATION
INCLUDING IDENTIFICATION AND DESCRIPTION

Major divisions			FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 3 inches and basing fractions on estimated weights)	GROUP SYMBOLS [a]	TYPICAL NAMES	INFORMATION REQUIRED FOR DESCRIBING SOILS	LABORATORY CLASSIFICATION CRITERIA	
COARSE GRAINED SOILS More than half of material is larger than No 200 sieve size [b] (The No 200 sieve size is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than No 4 sieve size (For visual classifications, the ¼" size may be used as equivalent to the No 4 sieve size)	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	GW	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name, indicate approximate percentages of sand and gravel, max size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbol in parentheses.	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between one and 3	
			Predominantly one size or a range of sizes with some intermediate sizes missing.	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.		Not meeting all gradation requirements for GW	
		GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)	GM	Silty gravels, poorly graded gravel-sand-silt mixtures.	For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics.	Atterberg limits below "A" line, or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
			Plastic fines (for identification procedures see CL below).	GC	Clayey gravels, poorly graded gravel-sand-clay mixtures.		Atterberg limits above "A" line with PI greater than 7	
	SANDS More than half of coarse fraction is smaller than No 4 sieve size	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.	SW	Well graded sands, gravelly sands; little or no fines.		$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between one and 3	
			Predominantly one size or a range of sizes with some intermediate sizes missing.	SP	Poorly graded sands, gravelly sands; little or no fines.	EXAMPLE:- Silty sand, gravelly; about 20% hard, angular gravel particles ½-in maximum size; rounded and subangular sand grains coarse to fine; about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (SM)	Not meeting all gradation requirements for SW	
		SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)	SM	Silty sands, poorly graded-sand-silt mixtures.		Atterberg limits below "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols.
			Plastic fines (for identification procedures see CL below)	SC	Clayey sands, poorly graded sand-clay mixtures		Atterberg limits above "A" line with PI greater than 7	

Use grain size curve in identifying the fractions as given under field identification

Determine percentages of gravel and sand from grain size curve. Depending on percentage of fines (fraction smaller than No 200 sieve size) coarse grained soils are classified as follows:- Less than 5% GW, GP, SW, SP. More than 12% GM, GC, SM, SC. 5% to 12% Borderline cases requiring use of dual symbols

Major divisions		IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN No. 40 SIEVE SIZE: DRY STRENGTH (CRUSHING CHARACTERISTICS)	DILATANCY (REACTION TO SHAKING)	TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT)	GROUP SYMBOLS	TYPICAL NAMES	INFORMATION REQUIRED FOR DESCRIBING SOILS
FINE GRAINED SOILS More than half of material is smaller than No 200 sieve size. (The No 200 sieve size is about the smallest particle visible to the naked eye)	SILTS AND CLAYS Liquid limit less than 50	None to slight	Quick to slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; color in wet condition, odor if any, local or geologic name, and other pertinent descriptive information; and symbol in parentheses.
		Medium to high	None to very slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
		Slight to medium	Slow	Slight	OL	Organic silts and organic silt-clays of low plasticity	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remolded states, moisture and drainage conditions.
	SILTS AND CLAYS Liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	
		High to very high	None	High	CH	Inorganic clays of high plasticity, fat clays.	EXAMPLE:- Clayey silt, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (ML)
		Medium to high	None to very slow	Slight to medium	OH	Organic clays of medium to high plasticity.	
HIGHLY ORGANIC SOILS		Readily identified by color, odor, spongy feel and frequently by fibrous texture.			Pt	Peat and other highly organic soils.	

PLASTICITY INDEX
COMPARING SOILS AT EQUAL LIQUID LIMIT
Toughness and dry strength increase with increasing plasticity index
"A" LINE
CL, ML, CL-ML, CH, OH, OL, MH
LIQUID LIMIT

PLASTICITY CHART
FOR LABORATORY CLASSIFICATION OF FINE GRAINED SOILS

[a] Boundary classifications - Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW-GC, well graded gravel-sand mixture with clay binder.
[b] All sieve sizes on this chart are U.S. standard.

FIELD IDENTIFICATION PROCEDURES FOR FINE GRAINED SOILS OR FRACTIONS

These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1/64 in. For field classification purposes, screening is not intended; simply remove by hand the coarse particles that interfere with the tests.

DILATANCY (Reaction to shaking)

After removing particles larger than No 40 sieve size, prepare a pat of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky.

Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens, and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

DRY STRENGTH (Crushing characteristics)

After removing particles larger than No 40 sieve size, mold a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun, or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.

High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

TOUGHNESS (Consistency near plastic limit)

After removing particles larger than the No 40 sieve size, a specimen of soil about one-half inch cube in size, is molded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eighth inch in diameter. The thread is then folded and rerolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.

After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.

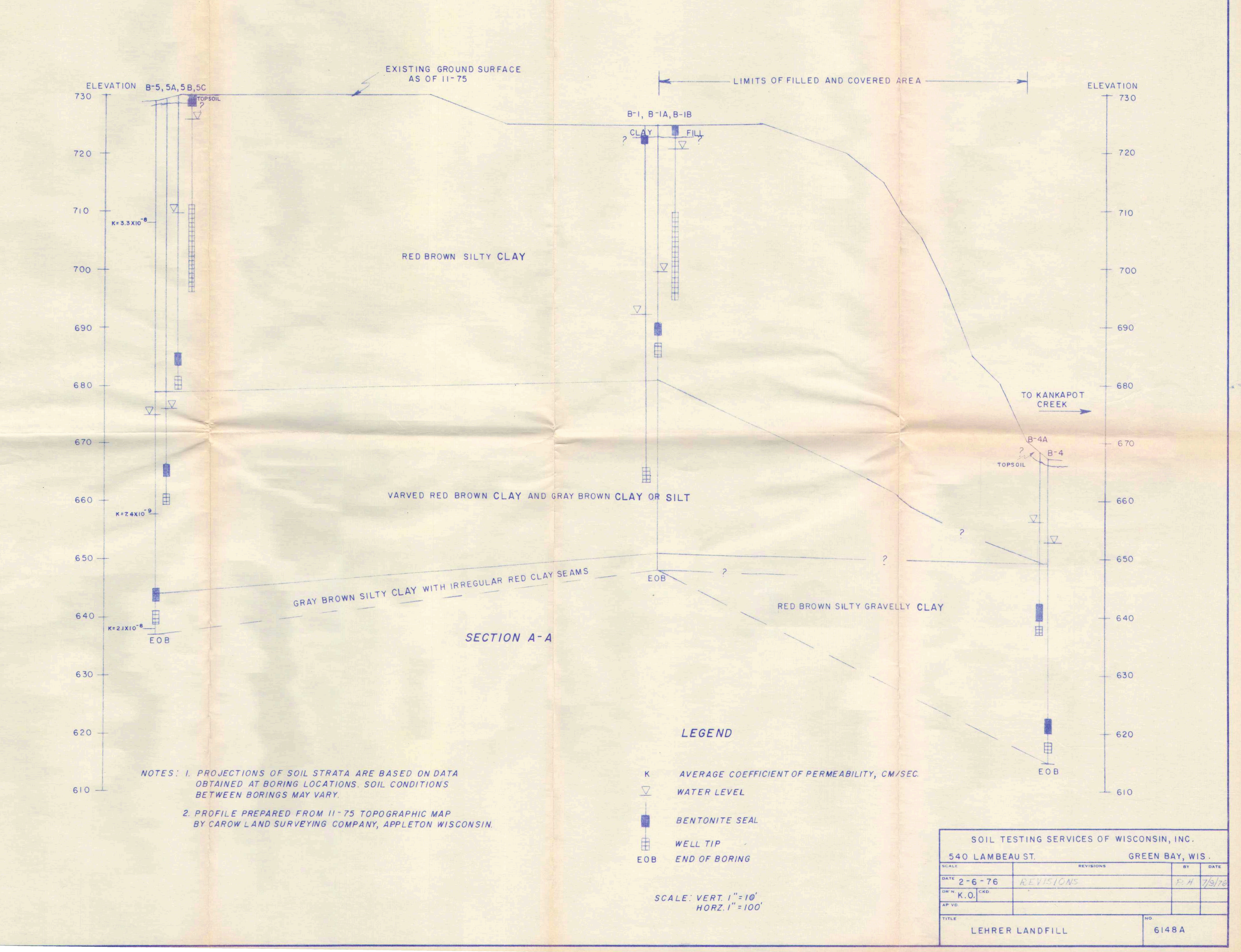
The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.

Highly organic clays have a very weak and spongy feel at the plastic limit.

ADOPTED BY - CORPS OF ENGINEERS AND BUREAU OF RECLAMATION - JANUARY 1952

103-D-347

Unified soil classification chart


GENERALIZED SOIL PROFILE
SECTION A-A
EXISTING GROUND SURFACE AS OF 11-75
ELEVATION
B-5, 5A, 5B, 5C
TOPSOIL
LIMITS OF FILLED AND COVERED AREA
B-1, B-1A, B-1B
CLAY
FILL
730
720
710
700
690
680
670
660
650
640
630
620
610
K=3.3X10^-8
K=7.4X10^-9
K=2.1X10^-8
RED BROWN SILTY CLAY
TO KANKAPOT CREEK
B-4A
B-4
TOPSOIL
VARVED RED BROWN CLAY AND GRAY BROWN CLAY OR SILT
GRAY BROWN SILTY CLAY WITH IRREGULAR RED CLAY SEAMS
RED BROWN SILTY GRAVELLY CLAY
EOB
SECTION A-A
LEGEND
K AVERAGE COEFFICIENT OF PERMEABILITY, CM/SEC.
WATER LEVEL
BENTONITE SEAL
WELL TIP
EOB END OF BORING
NOTES: 1. PROJECTIONS OF SOIL STRATA ARE BASED ON DATA OBTAINED AT BORING LOCATIONS. SOIL CONDITIONS BETWEEN BORINGS MAY VARY.
2. PROFILE PREPARED FROM 11-75 TOPOGRAPHIC MAP BY CAROW LAND SURVEYING COMPANY, APPLETON WISCONSIN.
SCALE: VERT. 1" = 10'
HORZ. 1" = 100'
SOIL TESTING SERVICES OF WISCONSIN, INC.
540 LAMBEAU ST.
GREEN BAY, WIS.
SCALE
REVISIONS
BY
DATE
DATE 2-6-76
REVISIONS
R.H.
7/9/76
DR'N K.O.
CKD
AP VD.
TITLE
LEHRER LANDFILL
NO.
6148A
BRUNING 40-105

GENERALIZED SOIL PROFILE
SECTION B-B

LIMITS OF FILLED AND COVERED AREA

EXISTING GROUND SURFACE AS OF 11-75

ELEVATION

730
720
710
700
690
680
670
660
650
640
630
620
610

B-3, B-3A, B-3B, B-3C

FUTURE FILL AREA

EXISTING FILL AREA

B-1A, B-1, B-1B

B-6B
B-6A
B-6

$K = 7.6 \times 10^{-9}$

$K = 1.9 \times 10^{-8}$

$K = 2.9 \times 10^{-8}$

$K = 3.5 \times 10^{-8}$

RED BROWN SILTY CLAY

RED BROWN SILTY CLAY

VARVED RED BROWN CLAY AND GRAY BROWN CLAY OR SILT

BROWN SILTY CLAY WITH TRACE TO SOME GRAVEL

GRAY BROWN SILTY CLAY WITH IRREGULAR RED CLAY SEAMS

VARVED GRAY BROWN SILT AND CLAY

GRAY BROWN OR BROWN SILTY, GRAVELLY CLAY

DOLOMITE BEDROCK

EOB

EOB

EOB

NOTES:
1. PROJECTIONS OF SOIL STRATA ARE BASED ON DATA OBTAINED AT BORING LOCATIONS. SOIL CONDITIONS BETWEEN BORINGS MAY VARY.
2. PROFILE PREPARED FROM 11-75 TOPOGRAPHIC MAP BY CAROW LAND SURVEYING COMPANY, APPLETON WISCONSIN

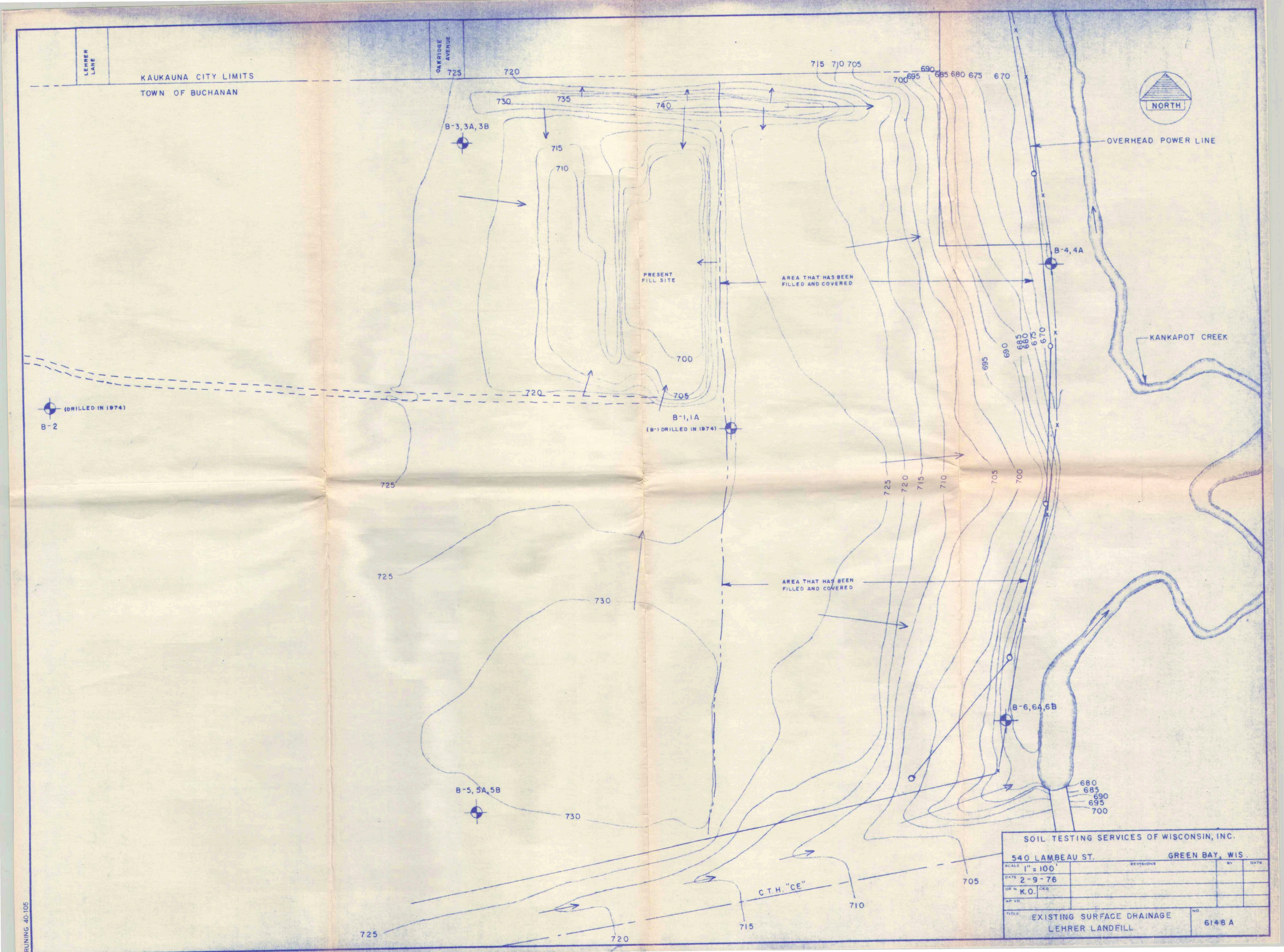
LEGEND

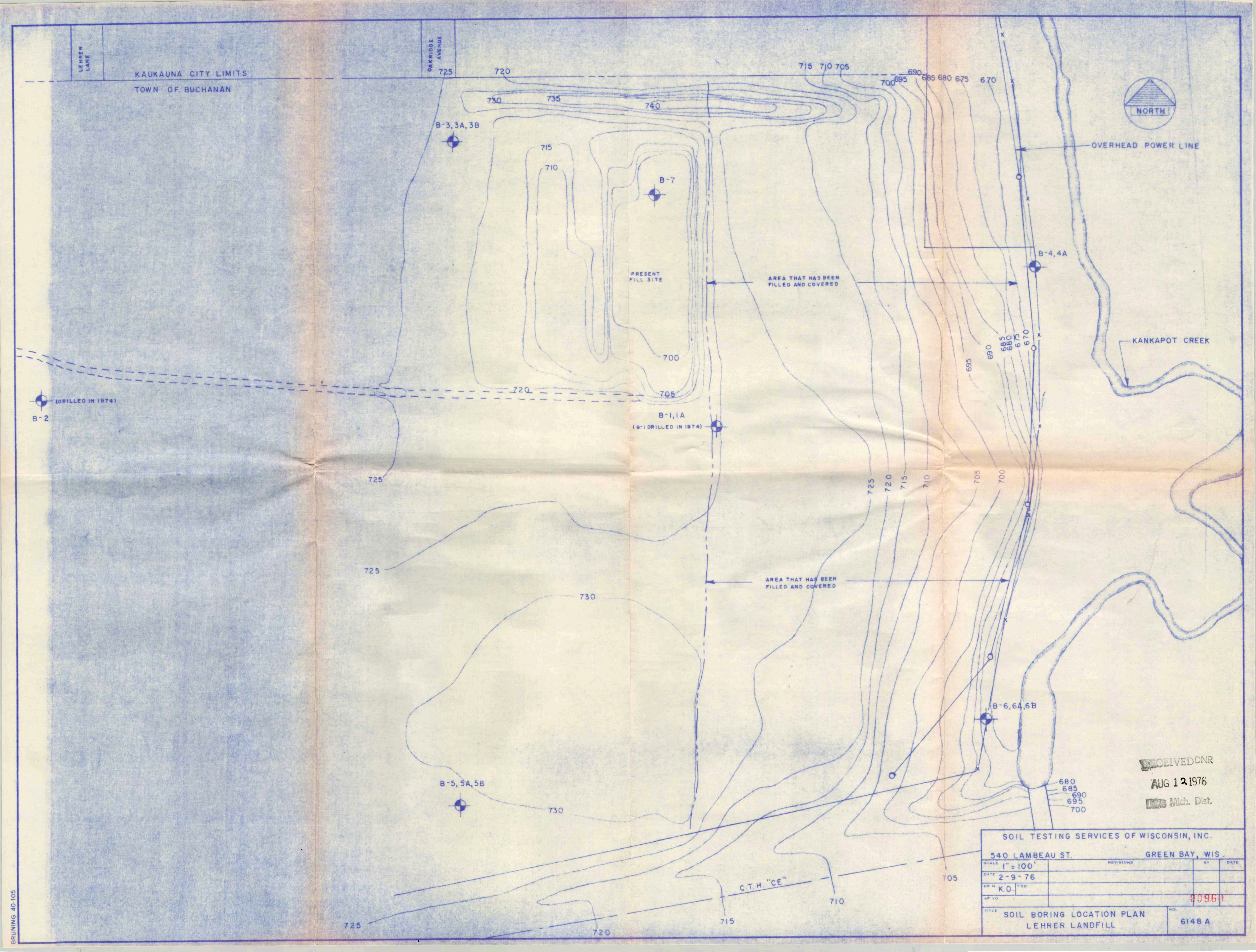
K	AVERAGE COEFFICIENT OF PERMEABILITY, CM/SEC.
▽	WATER LEVEL
	BENTONITE SEAL
	WELL TIP
EOB	END OF BORING

SCALE: VERT. 1" = 10'
HORZ. 1" = 100'

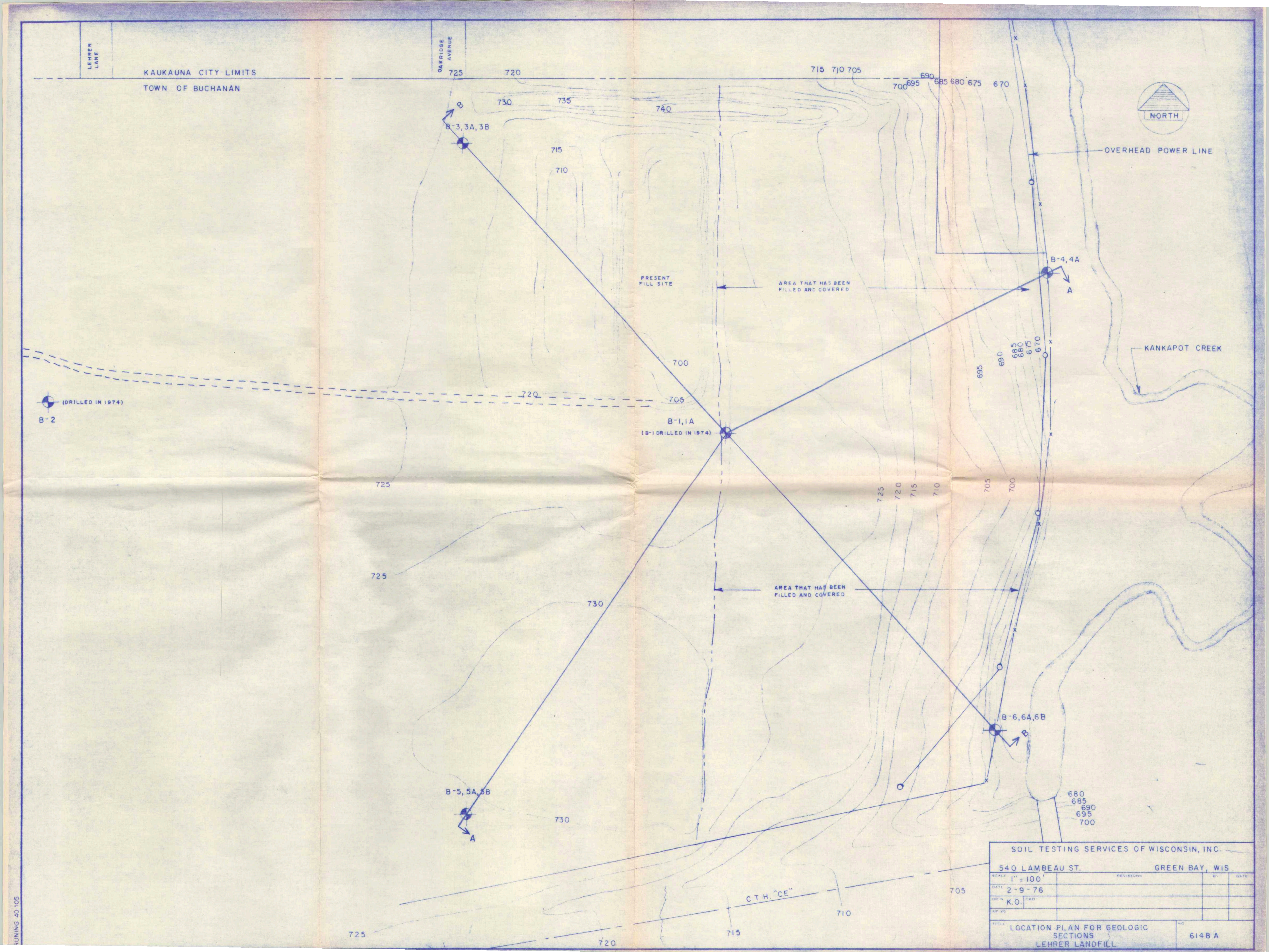
SOIL TESTING SERVICES OF WISCONSIN, INC.
540 LAMBEAU ST. GREEN BAY, WIS.

SCALE	REVISIONS	BY	DATE
DATE 2-9-76	REVISIONS	P.H.	7/9/76
DR'N K.O. CKD			
AP'VD			
TITLE LEHRER LANDFILL		NO. 6148 A	

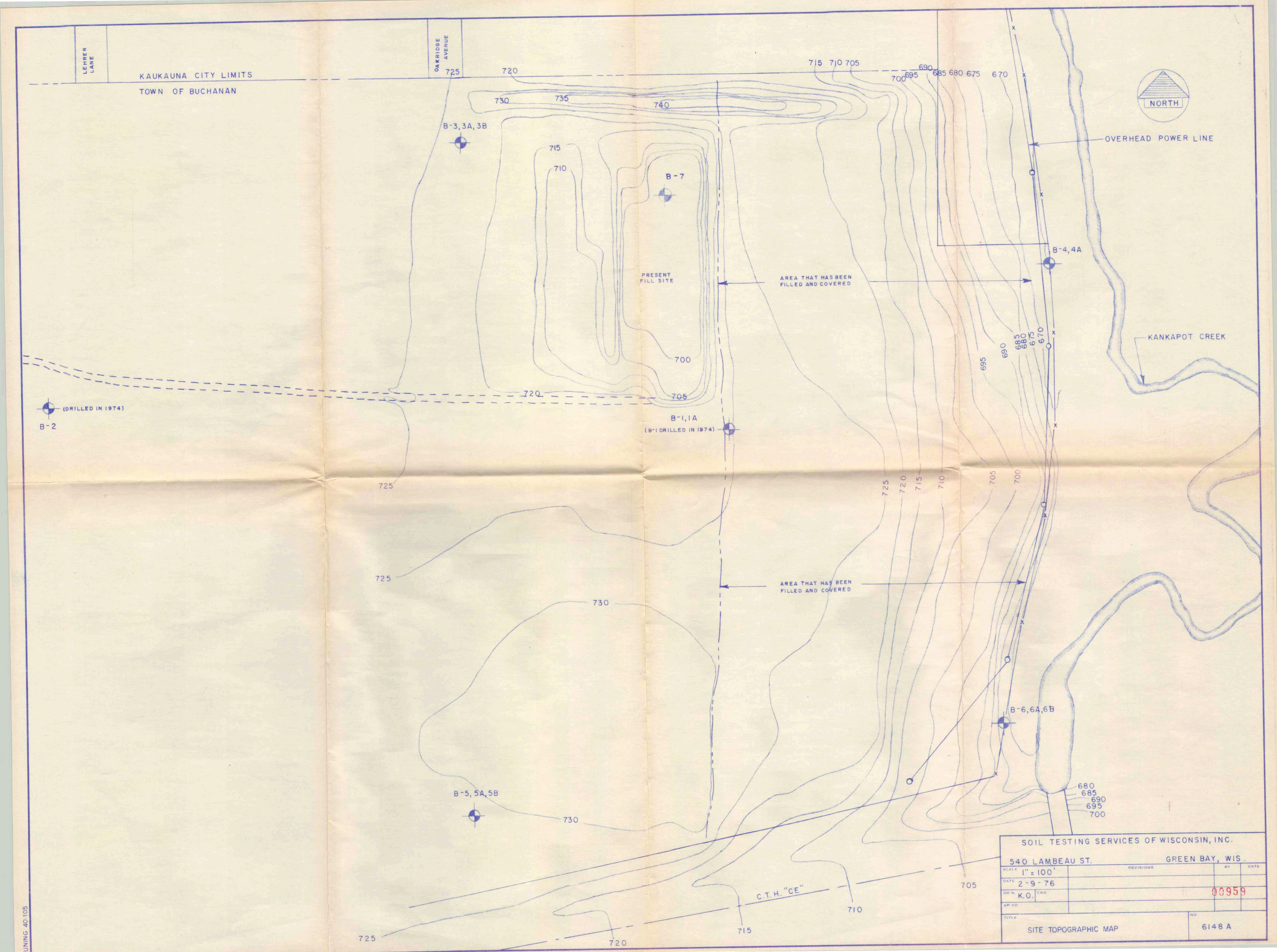

LEHRER LANE
OAKRIDGE AVENUE
KAUKAUNA CITY LIMITS
TOWN OF BUCHANAN
NORTH
OVERHEAD POWER LINE
KANKAPOT CREEK
B-3, 3A, 3B
B-4, 4A
PRESENT FILL SITE
AREA THAT HAS BEEN FILLED AND COVERED
B-2
(DRILLED IN 1974)
B-1, 1A
(B-1 DRILLED IN 1974)
B-6, 6A, 6B
B-5, 5A, 5B
C.T.H. "CE"
SOIL TESTING SERVICES OF WISCONSIN, INC.
540 LAMBEAU ST.
GREEN BAY, WIS.
SCALE 1" = 100'
DATE 2-9-76
DR'N K.O.
EXISTING SURFACE DRAINAGE
LEHRER LANDFILL
6148 A



LEHRER LANE
OAKRIDGE AVENUE
KAUKAUNA CITY LIMITS
TOWN OF BUCHANAN
NORTH
OVERHEAD POWER LINE
KANKAPOT CREEK
B-3, 3A, 3B
B-7
PRESENT FILL SITE
AREA THAT HAS BEEN FILLED AND COVERED
B-4, 4A
B-2
(DRILLED IN 1974)
B-1, 1A
(B-1 DRILLED IN 1974)
AREA THAT HAS BEEN FILLED AND COVERED
B-6, 6A, 6B
B-5, 5A, 5B
C.T.H. "CE"
RECEIVED DNR
AUG 12 1976
Mich. Dist.
SOIL TESTING SERVICES OF WISCONSIN, INC.
540 LAMBEAU ST.
GREEN BAY, WIS.
SCALE 1" = 100'
DATE 2-9-76
DR'N K.O.
00960
SOIL BORING LOCATION PLAN
LEHRER LANDFILL
NO. 6148 A
BRUNING 40-105



LEHRER LANE
OAKRIDGE AVENUE
KAUKAUNA CITY LIMITS
TOWN OF BUCHANAN
NORTH
OVERHEAD POWER LINE
B-3, 3A, 3B
B-4, 4A
PRESENT FILL SITE
AREA THAT HAS BEEN FILLED AND COVERED
KANKAPOT CREEK
(DRILLED IN 1974)
B-2
B-1, 1A
(B-1 DRILLED IN 1974)
AREA THAT HAS BEEN FILLED AND COVERED
B-6, 6A, 6B
B-5, 5A, 5B
C.T.H. "CE"
SOIL TESTING SERVICES OF WISCONSIN, INC.
540 LAMBEAU ST.
GREEN BAY, WIS.
1" = 100'
2-9-76
K.O.
LOCATION PLAN FOR GEOLOGIC SECTIONS LEHRER LANDFILL
6148 A


LEHRER LANE
OAKRIDGE AVENUE
KAUKAUNA CITY LIMITS
TOWN OF BUCHANAN
NORTH
OVERHEAD POWER LINE
B-3, 3A, 3B
B-7
PRESENT FILL SITE
AREA THAT HAS BEEN FILLED AND COVERED
B-4, 4A
KANKAPOT CREEK
(DRILLED IN 1974)
B-2
B-1, 1A
(B-1 DRILLED IN 1974)
AREA THAT HAS BEEN FILLED AND COVERED
B-6, 6A, 6B
B-5, 5A, 5B
C.T.H. "CE"
SOIL TESTING SERVICES OF WISCONSIN, INC.
540 LAMBEAU ST.
GREEN BAY, WIS.
SCALE 1" = 100'
REVISIONS
BY
DATE
DATE 2-9-76
DR'N K.O.
CKD
AP'VD
00959
TITLE
SITE TOPOGRAPHIC MAP
NO.
6148 A
UNING 40-105